Carnegie Mellon University

Undergraduate Catalog
2012-2013

Carnegie Institute of Technology
The College of Fine Arts
Dietrich College of Humanities and Social Sciences
H. John Heinz III College
Mellon College of Science
The School of Computer Science
Tepper School of Business
Carnegie Mellon University in Qatar
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Table of Contents

Foreword ................................................................. 4
Frequently Asked Questions ......................................... 7
Look at Carnegie Mellon ................................................ 8
Degrees Offered .......................................................... 10
Undergraduate Admission ............................................. 14
Summer Opportunities ................................................. 18
Division of Enrollment Services .................................... 20
University Policies ....................................................... 24
Undergraduate Academic Regulations .............................. 36
University Services ....................................................... 44
Undergraduate Options ............................................... 52
Department of Athletics and Physical Education ............... 56
Reserve Officers' Training Corps (ROTC) ......................... 58
Intercollegiate Programs .............................................. 62
   BXA Intercollegiate Degree Programs ......................... 70
   Bachelor of Science in Computational Biology ............... 62
   Bachelor of Science in Computational Finance .............. 62
   Minor in Computational Finance ............................... 64
   Minor in Health Care Policy and Management ............... 64
   Additional Major in Human-Computer Interaction .......... 65
   B.S. in Mathematical and Statistical Sciences ............... 66
   Bachelor of Science in Music and Technology ............... 66
   Major in Psychology & Biological Sciences ................ 67
   Science and Humanities Scholars Program ................. 68
Carnegie Institute of Technology .................................. 89
   Undergraduate Designated Minors ............................ 93
   CIT Minors for Non-Engineering Students .................. 98
   Department of Biomedical Engineering ..................... 100
   Department of Chemical Engineering ....................... 105
   Department of Civil and Environmental Engineering ..... 108
   Department of Electrical and Computer Engineering .... 111
   Department of Engineering and Public Policy ............. 117
   Department of Mechanical Engineering .................... 122
   Department of Materials Science and Engineering ....... 126
College of Fine Arts .................................................. 132
   Minors Offered by the College of Fine Arts ............... 135
   School of Architecture ........................................... 139
   School of Art ...................................................... 143
School of Design ..................................................... 146
School of Drama ...................................................... 150
School of Music ....................................................... 157
Dietrich College of Humanities and Social Sciences .......... 167
   Dietrich College Interdepartmental Majors ................ 174
   Dietrich College Interdepartmental Minors ................ 180
   Undergraduate Economics Program ......................... 187
   Department of English ......................................... 194
   Department of History ......................................... 203
   Department of Modern Languages ......................... 213
   Department of Philosophy .................................... 223
   Department of Psychology .................................. 230
   Department of Social and Decision Sciences .............. 236
   Department of Statistics .................................... 243
H. John Heinz III College ........................................... 249
Mellon College of Science .......................................... 253
   Minors Offered by the Mellon College of Science ........ 258
   Department of Biological Sciences ......................... 260
   Department of Chemistry .................................. 266
   Department of Mathematical Sciences ..................... 275
   Department of Physics ....................................... 283
School of Computer Science ....................................... 290
Tepper School of Business ......................................... 303
   Undergraduate Business Administration Program .......... 308
   Undergraduate Economics Program ....................... 311
Carnegie Mellon University in Qatar ............................. 319
Course Descriptions .................................................. 323
Foreword

This catalog is intended to detail the University’s academic programs, policies and services for use by current undergraduate students, faculty, and administrators. We appreciate that applicants, prospective students, and many other people will read this material, as well, for some understanding of University programs and culture.

Information in the catalog is current as of August 2012; the next Catalog will be published in August 2013. In the interim, new courses will be announced in the course schedules which are usually available in November and April and on the Web (www.cmu.edu/hub).

The program requirements and academic policies set forth in this Catalog are subject to change. As a consequence, students are expected to consult with their individual college or department for the most up-to-date information about program requirements, and should consult the University’s policy website for the most current statements of University policy.

Any changes or updated information from any member of the campus community should be directed to John Papinchak, University Registrar.

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Frequently Asked Questions

Q: What is the Undergraduate Catalog?
A: The Undergraduate Catalog, published every year, contains information about and academic requirements for each course of study or program available to undergraduate students at Carnegie Mellon, as well as course descriptions and university policies.

Q: For whom is the Undergraduate Catalog relevant?
A: The Undergraduate Catalog is most relevant for students entering in the year of publication. However, returning students should also use the Undergraduate Catalog to look at new programs and courses of study that may interest them.

Q: How often is the Undergraduate Catalog updated?
A: The Undergraduate Catalog is published every year. The next Catalog will be published in August 2013.

Q: The requirements for my major are different here than when I entered Carnegie Mellon; will my classes still count the same towards graduation?
A: Yes. A student’s requirements for graduation are determined by the year he or she enters Carnegie Mellon. If a program or major’s requirements change in a later catalog, these changes will only affect students entering during that Catalog year.

Note: The only exception is for courses which stop being taught or change course number. You should confer with your academic advisor each semester in order to be sure you are on track for graduation. You can also use the Academic Audit (https://enr-apps.as.cmu.edu/audit/audit) tool to check on your progress.

Q: Does the Catalog include course times and locations?
A: No. Current information on course times and locations can be found on Student Information Online (https://s3.as.cmu.edu/sio), under the Course Schedule tab.
Excellence in Practice and Learning for Life

Carnegie Mellon emphasizes a deep connection between theoretical knowledge and practice: the university’s interdisciplinary approach to education stresses the practical application and analysis of knowledge in institutional, social and historical contexts. “On a campus of 110 acres, research and teaching are conducted in more than 30 different fields of the arts, humanities, engineering, the sciences, social sciences, management and public policy. Students and faculty in these areas are in daily contact with one another, pursuing interdisciplinary projects, re-defining fields of knowledge, pushing their own visions of the possible and contributing to the world around them,” writes Jared L. Cohen, the eighth president of Carnegie Mellon in “The Innovative University,” a volume of writings that celebrated Carnegie Mellon’s centennial in 2000. Carnegie Mellon graduates are excellent practitioners in their chosen fields. The university is in the process of enriching and complementing this education to ensure that our students also gain broader, well-informed perspectives that will help them grow and change with the professions; interact wisely with the natural environment; and be responsible and informed citizens in an increasingly technological world and complex global culture.

From Technical School to International University

In a letter written in 1900, industrialist and philanthropist Andrew Carnegie offered to give the city of Pittsburgh $1 million in bonds to found a technical institute. The city provided 32 acres of land near Schenley Park, and the institution became known as the Carnegie Technical Schools. According to Carnegie’s plans, the institute would train the sons and daughters of working-class families in five schools: Science and Technology, to train draftsmen and engineer’s assistants; Fine and Applied Arts, for designers and art workers; Apprentices and Journeymen, for mechanics in manufacturing and construction; and Margaret Morrison Carnegie College, for home economists or secretaries. Within two decades, the Carnegie Technical Schools offered bachelor’s, master’s and doctor’s programs, and fittingly changed its name to the Carnegie Institute of Technology.

In 1967, the trustees of the Mellon Institute and the Carnegie Institute of Technology merged their institutions and adopted the name Carnegie Mellon University. In 1968, Margaret Morrison Carnegie College closed and the university organized a new College of Humanities and Social Sciences. New graduate-level colleges and schools also flourished, including the Graduate School of Industrial Administration (GSIA), the Heinz College of Public Policy and Management, and the School of Computer Science. As time progressed, new research centers and institutes developed on and off campus in specialties ranging from art conservation to sustainable computing. In 2004, GSIA was renamed the Tepper School of Business after alumnus David A. Tepper.

The Carnegie Institute of Technology has developed from a regional, technical college into Carnegie Mellon University, a selective, international research university that consistently ranks among the nation’s best colleges in U.S. News & World Report, Newsweek and BusinessWeek magazines. The university is also a leader in environmental sustainability and energy efficiency, and is home to the nation’s first Leadership in Energy and Environmental Design (LEED) certified dormitory. University Business magazine identified Carnegie Mellon as one of the nation’s Higher Education Sustainability Stars.

Undergraduate students may pursue majors in six of the university’s seven colleges: the Carnegie Institute of Technology (engineering), the College of Fine Arts, the Tepper School’s business administration program, the College of Humanities and Social Sciences, the Mellon College of Science, and the School of Computer Science. Carnegie Mellon also has campuses in California and Qatar and is expanding its presence in Europe, Australia and Asia with master’s programs and other educational partnerships.

A Unique Educational Experience

The university’s diversity, focus on strong student-faculty ties and commitment to education outside the classroom combine to create a learning environment that is as uniquely Carnegie Mellon as the Tartan plaid on the kilts of its bagpipers.

Carnegie Mellon strives for a campus culture that reflects a fundamental respect for different ways of living, working, and learning so every student has the opportunity to reach her or his potential. The university community is diverse, with roughly 5,300 undergraduates, 3,500 graduate students, and more than 1,200 faculty members. About 10% of undergraduate students are underrepresented minorities and 15% hail from countries outside the U.S. Faculty and graduate students also come from across the globe.

The university’s small student-to-faculty ratio gives students the opportunity for close interaction with their teachers - an essential component of academic success. But while professors spend a great deal of time with students, they also expect them to develop initiative, to critically assess their own progress and to work as teams. Working together, students and faculty create real-world projects with immediate impact. A design professor might critique a student’s sketches of a company logo, or a team of students will work with professors and researchers to design an autonomous robot for a race across the desert. Faculty at Carnegie Mellon take an interest in their students’ questions and concerns beyond the classroom. Some serve as academic advisors, while others seek undergraduate assistance with research projects or oversee student-proposed projects.

Equally important to the Carnegie Mellon education is the meta-curriculum, the learning that occurs outside classes through community service, interacting and learning in the university’s international community, or even just living in the residence halls.

Structure to Succeed, Freedom to Explore

A Carnegie Mellon education is marked by its strong focus on fundamental and versatile problem-solving skills in a specific discipline, but the university respects and values students’ varied talents and interests that often span many specialties. At Carnegie Mellon, students can explore more than one field of study while developing the strong professional core that is the hallmark of a Carnegie Mellon education. The university encourages students to expand their thinking in new and exciting dimensions, whether by taking courses from disciplines across the university or pursuing a double major or minor - frequently in a different college. Students can even design their own majors. In a community rich with seven colleges, the academic options are as varied as the students who pursue them.

Though academic interests may differ, the university has structured its programs so students develop skills vital to all professions, with communication and reflective practice acting as the common threads connecting these skills. In order to excel in any field and lead a life of social responsibility and lifelong learning, students must be able to switch between the theoretical basis and practical implications of knowledge and action, convey ideas and information effectively, and be reflective practitioners. Carnegie Mellon instills these qualities in students and gives them a wide array of perspectives and opportunities by creating an environment of learning-by-doing, providing them with a strong analytical background, and encouraging them to do and make.

Strength in Research and Artistic Creation

At Carnegie Mellon, faculty members aren’t just devoted teachers. They conduct groundbreaking research, create new and exciting art, and contribute to a growing global scholastic community. The university’s faculty are continuously innovating, and the new knowledge they create and the methods they discover routinely benefit classroom learning. Each college and dozens of special centers focus on issues and developments that affect the world beyond Carnegie Mellon.

Researchers in the Mellon College of Science received a $13.3 million grant to develop the National Center for Networks and Pathways, which will generate molecular bio-sensors that will change the way scientists look at living cells. A study by researchers in the College of Engineering found that cell phones and other portable electronic devices can interfere with the normal operation of critical electronics on airplanes. Meanwhile, in the university’s College of Humanities and Social Sciences, faculty have made critical strides toward understanding what causes autism and how it can be treated more effectively. The National Science Foundation recently funded a new Quality of Life Technology Engineering Research Center - a joint effort of Carnegie Mellon’s School of Computer Science and the University of Pittsburgh - that will design and commercialize technology to help older adults and people with disabilities live independently and productively. New research from the Tepper School of Business showed small retailers that the best way to compete with mega-marts is to use their existing customer data to develop new sales and marketing strategies. Students and faculty in the university’s School of Design have collaborated with local foundations to create Explanatoids, cartoons designed to illustrate the importance of science, math and technology to the Pittsburgh region while stressing the
role girls play in the careers of the future. Just down the road, faculty in the Heinz College are breaking new ground with studies on the different ways men and women negotiate.

Exploring Research and Creative Projects
Faculty aren't the only people busy with research on campus. Research is a vital component of undergraduate education at Carnegie Mellon. Students can initiate projects of their own or become involved with existing ones on campus. The Department of Biological Sciences, for example, has faculty mentors who help interested students find research opportunities that support their own intellectual curiosity. Drama students participate in every facet of productions, from set construction to acting. Students across campus are encouraged to work with faculty to pursue their own interests, and most departments offer courses for independent study that allow undergraduates to work on projects of their own design under the guidance of a faculty member.

Research projects often come with a financial cost, but Carnegie Mellon offers many sources of funding for students conducting independent research and creative projects. One popular source of funding is the university's Small Undergraduate Research Grant (SURG) program offered through the Undergraduate Research Initiative. (For more information, see the Undergraduate Research Initiative section in this catalog under "University Services.") These types of funding programs, combined with the support and encouragement offered by faculty and staff on campus bring research - traditionally the mark of graduate education - into the undergraduate realm.

The World of Carnegie Mellon
Carnegie Mellon is often described as a competitive place - and it is. The university selects students from among the best in the world, so attending Carnegie Mellon means that you'll be with students who, like you, were at the top of their classes in high school. The university also stresses collaboration and teamwork, often across disciplines, where students share common goals and tasks while still bringing something unique to the interaction. Carnegie Mellon students are serious scholars who want to excel. The atmosphere is intense and demanding, but also encouraging and rewarding. Carnegie Mellon graduates enter society prepared to assume even greater challenges and equipped with an awareness of their own strengths and abilities.

But Carnegie Mellon students still have fun, and spend their free time planning for the coming weekend and forging some of the strongest friendships they've ever known. Students don't just develop a strong work ethic at Carnegie Mellon - they develop a strong sense of community. Through residence hall living, community service, group projects and numerous activities and clubs, students find they can belong to a range of communities. Carnegie Mellon also has the tradition of Spring Carnival, an annual three-day event whose buggy races and booths involve students and alumni from a multitude of academic and cultural backgrounds.

Carnegie Mellon Impacts the World
As a Carnegie Mellon graduate, you'll join a highly respected group of individuals who have changed the world as we know it. Whether pursuing further education or entering the work force, alumni consistently achieve the high goals they've set for themselves in a wide variety of academic and professional fields. One alumna wrote the songs for "Godspell," while an alumna won the Tony Award for Best Performance by a Leading Actress in a Play for her performance in the Pulitzer Prize-winning "Doubt." Carnegie Mellon alumni created and starred in "Hill Street Blues," "L.A. Law," "NYPD Blue," "ER" and "Lost." More than 2,000 of our graduates are corporate chairs, presidents or vice presidents. Some 1,400 alumni are university professors and another 30 are deans. Many more symphonies across the country include Carnegie Mellon alumni. The university's graduates are also involved in formal classroom settings and in a variety of informal contexts, their learning.

Carnegie Mellon will meet the changing needs of society by building on its traditions of innovation, problem solving, and interdisciplinarity.

Our Mission
To create and disseminate knowledge and art through research and creative inquiry, teaching, and learning, and to transfer our intellectual and artistic product to enhance society in meaningful and sustainable ways.

To serve our students by taching them problem solving, leadership and teamwork skills, and the value of a commitment to quality, ethical behavior, and respect for others.

To achieve these ends by pursuing the advantages of a diverse and relatively small university community, open to the exchange of ideas, where discovery, creativity, and personal and professional development can flourish.

Our Values
• Dedication, as exemplified by our commitment to the critical issues of society and our uncompromising work ethic.
• Collaboration, as exemplified by our interdisciplinarity, our external partnerships, and our capacity to create new fields of inquiry.
• Measuring excellence by impact, as exemplified by our focus on issues critical to regional development, national interest, and global welfare.
• Entrepreneurship, as exemplified by openness to new ideas, prudent use of resources, and readiness to act.
• Depth driving breadth, as exemplified by our issue-driven research, our context-based general education initiatives, and our focus on problem solving and creative production at all levels.
• Compassion, as exemplified by our focus on human welfare, on the betterment of society, and on the personal development of the members of our community.
• Integrity and inclusion, as exemplified by our attention to the highest ethical standards in all domains, and our commitment to being a community which welcomes talented minds from diverse backgrounds and challenges them individually and collectively to achieve their best.

Carnegie Mellon's undergraduate educational programs are designed to help students acquire the following:
• Depth of knowledge in their chosen areas of specialization and genuine intellectual breadth in other fields.
• Creativity and intellectual playfulness, moving beyond established knowledge and practice to create imaginative ideas and artifacts.
• Skilled thoughtfulness and critical judgment, which allow them to evaluate new ideas, identify and solve or explore problems, and appreciate a variety of different forms of analysis and thought.
• Skills of independent learning, which enable them to grow in wisdom and keep abreast of changing knowledge and problems in their profession and the world.
• A set of values, including commitment to personal excellence and intellectual adventure, concern for the freedoms and dignity of others, and sensitivity to the special professional and social responsibilities that come with advanced learning and positions of leadership.
• The self-confidence and resourcefulness necessary to take action and get things done.
• The ability to communicate with others on topics both within and outside their chosen field of specialization.

Most instruction at Carnegie Mellon is focused on fundamentals useful in later learning, rather than on particulars of knowledge and techniques that may soon become obsolete. Advanced courses provide students with the opportunity to refine their skills by applying and exercising the fundamentals they have acquired in earlier courses and by exploring new analytical and creative directions. In a world that has sometimes placed too little emphasis on skill, Carnegie Mellon takes pride in educating students who display excellence in application-students who can do useful things with their learning.

Values, including sensitivity to the feelings, needs and rights of others, are learned in part through example. To this end, the faculty and staff of Carnegie Mellon work to provide a supportive and caring environment that values and respects intellectual, philosophical, personal and cultural diversity. The faculty strive to identify and discuss with their students, both in formal classroom settings and in a variety of informal contexts, their responsibilities as professionals, citizens and human beings, and to teach through example.

The undergraduate programs at Carnegie Mellon are designed to help our students become accomplished professionals who are broadly educated, independent and humane leaders.
Degrees Offered

The following list shows all primary degrees offered for both undergraduate and graduate students at Carnegie Mellon University.

Carnegie Institute of Technology
Interdepartmental
• M.S. in Engineering and Technology Innovation Management
• M.S. in Energy Science, Technology and Policy (jointly offered by Civil and Environmental Engineering and Materials Science and Engineering)

Biomedical Engineering
• B.S. in an engineering discipline and Biomedical Engineering (link) (p. 100)
• M.S. in Biomedical Engineering
• Ph.D. in Biomedical Engineering

Chemical Engineering
• B.S. in Chemical Engineering (link) (p. 105)
• M. Chemical Engineering
• M. Chemical Engineering and Colloids, Polymers and Surfaces
• M.S. in Chemical Engineering
• M.S. in Colloids, Polymers and Surfaces (jointly with Mellon College of Science)
• Ph.D. in Chemical Engineering

Civil and Environmental Engineering
• B.S. in Civil Engineering (link) (p. 108)
• M.S. in Advanced Infrastructure Systems
• M.S. in Civil and Environmental Engineering
• M.S. in Civil Engineering
• M.S. in Civil and Environmental Engineering and Management (jointly with the Tepper School of Business)
• M.S. in Computational Mechanics
• M.S. in Energy Science, Technology and Policy (jointly with Materials Science and Engineering)
• M.S. in Environmental Engineering
• M.S. in Environmental Management and Science
• Ph.D. in Advanced Infrastructure Systems
• Ph.D. in Civil and Environmental Engineering
• Ph.D. in Civil and Environmental Engineering/Engineering and Public Policy (dual degree offered with Engineering and Public Policy)
• Ph.D. in Civil Engineering
• Ph.D. in Computational Mechanics
• Ph.D. in Environmental Engineering
• Ph.D. in Environmental Management and Science

Electrical and Computer Engineering
• B.S. in Electrical and Computer Engineering (link) (p. 111)
• B.S. in Music and Technology (jointly with the Department of Music and the School of Computer Science)
• M.S. in Electrical and Computer Engineering
• M.S. in Music and Technology (jointly with the Department of Music and the School of Computer Science)
• Ph.D. in Electrical and Computer Engineering

Engineering and Public Policy
• B.S. in an engineering discipline and Engineering and Public Policy (link) (p. 117)
• M.S. in Engineering and Public Policy
• Ph.D. in Engineering and Public Policy and an engineering discipline
• Ph.D. in Engineering and Public Policy

Information Networking Institute
• M.S. in Information Networking
• M.S. in Information Security Technology and Management
• M.S. in Information Technology - Information Security
• M.S. in Information Technology - Mobility
• M.S. in Information Technology - Software Management

Mechanical Engineering
• B.S. in Mechanical Engineering (link) (p. 123)
• M.S. in Computational Design and Manufacturing
• M.S. in Mechanical Engineering
• Ph.D. in Mechanical Engineering

Materials Science and Engineering
• B.S. in Materials Science and Engineering (link) (p. 126)
• M.S. in Materials Science and Engineering
• Ph.D. in Materials Science and Engineering

Silicon Valley Campus
• M.S. in Software Engineering
• M.S. in Software Engineering - Development Management
• M.S. in Software Management

College of Fine Arts

Architecture
• B. of Architecture (5-year program) (link) (p. 139)
• M.S. in Architecture
• M.S. in Building Performance and Diagnostics
• M.S. in Computational Design
• M.S. in Sustainable Design
• M. of Tangible Interaction Design
• M. of Urban Design
• Ph.D. in Building Performance and Diagnostics
• Ph.D. in Computational Design

Art
• B.F.A. in Art (link) (p. 143)
• M.F.A. in Art

Design
• B.F.A. in Communication Design (link) (p. 146)
• B.F.A. in Industrial Design (link) (p. 146)
• M. Design in Interaction Design
• Ph.D. in Design

Drama
• B.F.A. in Drama (link) (p. 150)
• M.F.A. in Costume Design
• M.F.A. in Costume Production
• M.F.A. in Directing
• M.F.A. in Dramatic Writing
• M.F.A. in Lighting Design
• M.F.A. in Production Technology and Management
• M.F.A. in Scene Design
• M.F.A. in Sound Design

Music
• B.F.A. in Music (link) (p. 157)
• B.F.A. in Music (Composition) (link) (p. 157)
• B.F.A. in Music Performance (link) (p. 157)
• B.S. in Music and Technology (jointly with the Department of Electrical and Computer Engineering and the School of Computer Science) (link) (p. 161)
• M. Music in Composition
• M. Music in Conducting
• M. Music in Music Education
• M. Music in Performance
• M.S. in Music and Technology (jointly with the Department of Electrical and Computer Engineering and the School of Computer Science)

Dietrich College of Humanities and Social Sciences

Interdepartmental
• B.A./B.S. in Ethics, History, and Public Policy (jointly offered by the Departments of History and Philosophy) (link) (p. 175)
• B.A. in European Studies (jointly offered by the Departments of Modern Languages and History) (link) (p. 177)
• B.S. in Economics and Mathematical Sciences (jointly offered by the Undergraduate Economics Program and the Department of Mathematical Sciences) (link) (p. 189)
• B.S. in Economics and Statistics (jointly offered by the Department of Statistics and the Undergraduate Economics Program) (link) (p. 174)
• B.S. in Information Systems (link) (p. 210)
• B.A. in Linguistics (jointly offered by the Departments of English, Modern Languages, Philosophy, and Psychology) (link) (p. 176)
• B.S. in Psychology and Biological Sciences (jointly offered by the Department of Psychology and the Department of Biological Sciences) (link) (p. 231)

Center for the Neural Basis of Cognition
• Ph.D. in Neural Computation

Economics (jointly offered by Dietrich College and Tepper School of Business unless otherwise noted)
• B.A. in Economics (link) (p. 188)
• B.S. in Economics (link) (p. 188)
• B.S. in Economics and Mathematical Sciences (jointly offered by the Undergraduate Economics Program and the Department of Mathematical Sciences) (link) (p. 189)
• B.S. in Economics and Statistics (jointly offered by the Department of Statistics and the Undergraduate Economics Program) (link) (p. 190)
• Ph.D. in Economics (Tepper only)
• Ph.D. in Economics and Public Policy (Tepper only, jointly with Heinz College)

English
• B.A. in Creative Writing (link) (p. 196)
• B.A. in English (link) (p. 194)
• B.A. in Professional Writing (link) (p. 196)
• B.S. in Technical Writing and Communication (link) (p. 198)
• M.A. in Literary and Cultural Studies
• M.A. in Professional Writing
• M.A. in Rhetoric
• M. Litt in Investigative Journalism (jointly with the University of Strathclyde [Glasgow, Scotland])
• M. Litt in Renaissance and Early Modern Studies (jointly with the University of Strathclyde [Glasgow, Scotland])
• Ph.D. in Literary and Cultural Studies
• Ph.D. in Rhetoric

History
• B.A. in History (link) (p. 203)
• B.A./B.S. in Ethics, History, and Public Policy (jointly with the Department of Philosophy) (link) (p. 207)
• B.A. in Global Studies (link) (p. 204)
• M.A. in History
• Ph.D. in History

Modern Languages
• B.A. in Chinese Studies (link) (p. 213)
• B.A. in French and Francophone Studies (link) (p. 214)
• B.A. in German Studies (link) (p. 215)
• B.A. in Hispanic Studies (link) (p. 216)
• B.A. in Japanese Studies (link) (p. 217)
• B.A. in Russian Studies (link) (p. 218)
• M.A. in Applied Second Language Acquisition
• M.A. in Second Language Acquisition
• Ph.D. in Second Language Acquisition

Philosophy
• B.A. in Philosophy (link) (p. 226)
• B.A./B.S. in Ethics, History, and Public Policy (jointly with the Department of History) (link) (p. 223)
• B.S. in Logic and Computation (link) (p. 225)
• M.A. in Philosophy
• M.A. in Second Language Acquisition
• M.S. in Logic, Computation and Methodology
• Ph.D. in Logic, Computation and Methodology

Psychology
• B.A./B.S. in Psychology (link) (p. 230)
• B.S. in Cognitive Science (link) (p. 232)
• B.S. in Psychology and Biological Sciences (jointly with the Department of Biological Sciences) (link) (p. 231)
• Ph.D. in Psychology
• Ph.D. in Psychology and Behavioral Design Research (jointly with the Department of Social and Decision Sciences)

Social and Decision Sciences
• B.S. in Decision Science (link) (p. 236)
• B.S. in International Relations and Politics (link) (p. 237)
• B.S. in Policy and Management (link) (p. 239)
• M.S. in Behavioral Decision Research
• M.S. in Information Technology Strategy (jointly with the Carnegie Institute of Technology and the School of Computer Science)
• M.S. in Social and Decision Sciences
• M.S. in Strategy, Entrepreneurship, and Technological Change (jointly with the Tepper School of Business, Heinz College, and the Department of Engineering and Public Policy)
• Ph.D. in Behavioral Decision Research
• Ph.D. in Psychology and Behavioral Decision Research (jointly with the Department of Psychology)
• Ph.D. in Social and Decision Sciences
• Ph.D. in Strategy, Entrepreneurship, and Technological Change (jointly with the Tepper School of Business, Heinz College, and the Department of Engineering and Public Policy)

Statistics
• B.S. in Economics and Statistics (jointly with the Undergraduate Economics Program and Tepper School of Business) (link) (p. 245)
• B.S. in Statistics (link) (p. 243)
• M.S. in Statistical Practices
• Ph.D. in Statistics
• Ph.D. in Statistics and Machine Learning (jointly with the Department of Machine Learning)
• Ph.D. in Statistics and Public Policy (jointly with the Heinz College)
• Ph.D. in Neural Cognition and Statistics (jointly with the Center for the Neural Basis of Cognition)

H. John Heinz III College

School of Information Systems & Management
• M. of Information Systems Management
• M.S. in Information Security Policy and Management
• M.S. in Information Technology
• M.S. in Information Technology - Information Security and Assurance
• M.S. in Information Technology - Information Systems Management
• M.S. in Information Technology - Information Technology Management
• M.S. in Information Technology - Software Design and Management
• M.S. in Information Technology - Software Engineering (jointly with the School of Computer Science)
• Ph.D. in Information Systems Management

School of Public Policy & Management
• M. of Medical Management
• M. of Public Management
• M.S. in Biotechnology and Management (jointly with Mellon College of Science and Tepper School of Business)
• M.S. in Health Care Policy and Management
• M.S. in Health Care Policy and Management and M.B.A. (jointly with Tepper School of Business)
• M.S. in Public Policy and Management
• M.S. in Public Policy and Management and M.B.A. (jointly with Tepper School of Business)
• M.S. in Public Policy and Management and J.D. (jointly with the University of Pittsburgh School of Law)
• M.S. in Public Policy and Management and M. of Divinity (jointly with the Pittsburgh Theological Seminary)
• Ph.D. in Public Policy and Management
• Ph.D. in Economics and Public Policy (jointly with the Tepper School of Business)
• Ph.D. in Machine Learning and Public Policy (jointly with the School of Computer Science)
• Ph.D. in Statistics and Public Policy (jointly with College of Humanities and Social Sciences)

Adelaide, South Australia Campus
• M.S. in Information Technology
• M.S. in Public Policy and Management

Mellon College of Science

Biological Sciences
• B.A. in Biological Sciences (link) (p. 262)
• B.S. in Biological Sciences (link) (p. 260)
• B.S. in Biological Sciences/Neuroscience Track
• B.S. in Biological Sciences and Psychology (jointly with the Department of Psychology) (link) (p. 262)
• B.S. in Computational Biology (jointly with the Lane Center for Computational Biology) (link) (p. 62)
• M.S. in Biological Sciences
• M.S. in Computational Biology (jointly with the Lane Center for Computational Biology)
• Ph.D. in Biological Sciences

Chemistry
• B.A. in Chemistry (link) (p. 270)
• B.S. in Chemistry (link) (p. 267)
• M.S. in Chemistry
• M.S. in Colloids, Polymers, and Surfaces (jointly with the Department of Chemical Engineering)
• Ph.D. in Chemistry

Mathematical Sciences
• B.S. in Mathematical Sciences (link) (p. 275)
• M.S. in Algorithms, Combinatorics, and Optimization
• M.S. in Mathematical Sciences
• D.A. in Mathematical Sciences
• Ph.D. in Mathematical Finance
• Ph.D. in Mathematical Sciences
• Ph.D. in Pure and Applied Logic (jointly with the Department of Philosophy and the School of Computer Science)

Physics
• B.A. in Physics (link) (p. 285)
• B.S. in Physics (link) (p. 283)
• M.S. in Physics
• Ph.D. in Applied Physics
• Ph.D. in Physics

School of Computer Science

Computer Science
• B.S. in Computer Science (link) (p. 290)
• B.S. in Economics (link) (p. 290)
• M.S. in Algorithms, Combinatorics, and Optimization
• M.S. in Computational Finance (offered jointly with the Tepper School of Business and the Heinz College)
• M.S. in Computer Science
• M.S. in Computer Science (5th Year Scholars Program only)
• M.S. in Music and Technology (jointly with the Departments of Electrical and Computer Engineering and Music)
• M.S. in Pure and Applied Logic (jointly with the Department of Mathematical Sciences and the Department of Philosophy)
• Ph.D. in Algorithms, Combinatorics and Optimization
• Ph.D. in Computer Science
• Ph.D. in Pure and Applied Logic (jointly with the Department of Mathematical Sciences and the Department of Philosophy)

Human-Computer Interaction
• M.S. in Human-Computer Interaction
• M. of Human-Computer Interaction
• Ph.D. in Human-Computer Interaction

Institute for Software Research
• M.S. in Computation, Organizations and Society
• M.S. in Information Technology – eBusiness Technology
• M.S. in Information Technology - Very Large Information Systems
• Ph.D. in Computation, Organizations and Society
• Ph.D. in Software Engineering

Ray and Stephanie Lane Center for Computational Biology
• B.S. in Computational Biology (jointly with the Department of Biological Sciences)
• M.S. in Computational Biology (jointly with the Department of Biological Sciences)
• M.S. in Biotechnology Innovation and Computation (jointly with the Lane Center for Computational Biology)
• Ph.D. in Computational Biology

Language Technologies Institute
• M.S. in Language Technologies
• M.S. in Biotechnology Innovation and Computation (jointly with the Lane Center for Computational Biology)
• Ph.D. in Language Technologies

Machine Learning
• M.S. in Machine Learning
• Ph.D. in Machine Learning
• Ph.D. in Machine Learning & Public Policy (jointly with the Heinz College)
• Ph.D. in Statistics and Machine Learning (jointly with College of Humanities and Social Sciences)

Robotics Institute
• M.S. in Robotics Technology
• M.S. in Robotics
• M.S. in Robotic Systems Development
• Ph.D. in Robotics

Software Engineering
• M. of Software Engineering
• M.S. in Information Technology - Embedded Software Engineering
• M.S. in Information Technology - eBusiness Technology
• M.S. in Information Technology (Software Engineering)
• M.S. in Information Technology - Software Engineering Management
• Ph.D. in Software Engineering

David A. Tepper School of Business

• B.A. in Economics (link) (p. 312)
• B.S. in Economics (link) (p. 312)
• B.S. in Economics and Mathematical Sciences (jointly offered by Dietrich College, the Department of Mathematical Sciences, and Tepper School of Business) (link) (p. 313)
• B.S. in Economics and Statistics (jointly offered by the T epper School of Business and the Department of Statistics) (link) (p. 245)
• B.S. in Business Administration (link) (p. 308)
• M.B.A. in Business Administration
• M.B.A./M.S.C.F in Business Management and Computational Finance (jointly with Dietrich College, Mellon College of Science, and Heinz College).
• M.B.A./M.S.P.P.M. in Business Management and Public Policy Management (jointly with Heinz College)
• M.B.A./M.S.C.E.E. in Business Management and Civil and Environmental Engineering (in association with Carnegie Institute of Technology)
• M.B.A in Business Management and J.D. in Law (jointly with the University of Pittsburgh Law School)
• M.B.A/M.H.C.P.M. in Business Management and Health Care Policy (jointly with Heinz College)
• M.B.A/ M.S.S.E. in Business Management and Software Engineering (jointly with the School of Computer Science)
• M.S. in Computational Finance (jointly with Dietrich College, the Mellon College of Science, and Heinz College)
• Ph.D. in Accounting
• Ph.D. in Algorithms, Combinatorics, and Optimization (jointly with the School of Computer Science)
• Ph.D. in Economics
• Ph.D. in Finance
• Ph.D. in Information Systems
• Ph.D. in Management of Manufacturing and Automation (with Robotics Institute)
• Ph.D. in Marketing
• Ph.D. in Operations Management and Manufacturing
• Ph.D. in Operations Research
• Ph.D. in Organizational Behavior and Theory
• Ph.D. in Economics and Public Policy (jointly with Heinz College)
• Ph.D. in Strategy, Entrepreneurship, and Technological Change (jointly with the Department of Social and Decision Sciences, Heinz College, and the Department of Engineering and Public Policy)

University-Wide, Intercollege, and Joint Degree Programs

Architecture-Engineering-Construction Management Program
• M.S. in Architecture-Engineering-Construction Management (jointly with the Department of Civil and Environmental Engineering and the School of Architecture)
• Ph.D. in Architecture-Engineering-Construction Management (jointly with the Department of Architecture)

Arts Management
• M. of Arts Management (jointly with the College of Fine Arts and Heinz College)
• M. of Arts Management (jointly with the College of Fine Arts and Heinz College) and Graduate Degree in Innovation and Organization of Culture and the Arts (jointly with the University of Bologna’s School of Economics)
• M. of Arts Management (jointly with the College of Fine Arts and Heinz College) and J.D. (jointly with the University of Pittsburgh School of Law)

BXA Intercollege Degree Programs
• B. of Humanities and Arts (jointly with the College of Humanities and Social Sciences and the College of Fine Arts) (link) (p. 70)
• B. of Science and Arts (jointly with the Mellon College of Science and the College of Fine Arts) (link) (p. 78)
• B. of Computer Science and Arts (jointly with the School of Computer Science and the College of Fine Arts) (link) (p. 82)

Communication Planning and Information Design Program
• M. Design in Communication Planning and Information Design (jointly with the School of Design and the Department of English)

Computational Finance Program
• B.S. in Computational Finance (jointly with the College of Humanities and Social Sciences, Heinz College, Mellon College of Science and Tepper School of Business) (link) (p. 62)
• M.S. in Computational Finance (jointly with the College of Humanities and Social Sciences, Heinz College, Mellon College of Science and Tepper School of Business)

Entertainment Industry Management
• M. of Entertainment Industry Management (jointly with the College of Fine Arts and Heinz College)

Entertainment Technology Center
• M. of Entertainment Technology

Master of Product Development Program
• M. of Product Development (jointly with the Department of Mechanical Engineering and the School of Design)

Science and Humanities Scholars Program
• B.A./B.S. in various disciplines (jointly with the Dietrich College of Humanities and Social Sciences and the Mellon College of Science) (link) (p. 68)

Carnegie Mellon University in Qatar

Qatar Biological Sciences
• B.S. in Biological Sciences
• B.S. in Computational Biology

Qatar Business Administration
• B.S. in Business Administration

Qatar Computer Science
• B.S. in Computer Science

Qatar Information Systems
• B.S. in Information Systems
Undergraduate Admission

Michael A. Steidel, Director of Admission
Office: Warner Hall, Admission Lobby, First Floor
http://www.cmu.edu/admission

Admission Philosophy
At Carnegie Mellon, we select our freshman class from a large group of very qualified candidates. We don’t use a calculation to arrive at our admitted class. Calculations can’t take into account all of the factors we like to consider when making admission decisions. We treat every application individually and take great care in making our admission practices fair, thorough and sensitive. We are interested in students who can be successful at Carnegie Mellon and take full advantage of all the university has to offer and enriching our campus community.

Admission Criteria
The majority of our applicants are admissible and could be successful at Carnegie Mellon. We use a variety of factors to select our first-year class from those admissible candidates. High school performance weighs most heavily in our admission decision because it is the most meaningful measure of a student’s abilities. We pay close attention to the type of courses taken and to the grades received, and to the challenges you’ve given yourself in the classroom. If you are applying to programs in the arts, your artistic performance becomes the single most important factor (depending on the program) in our admission decision.

Standardized test scores add to our knowledge of a student’s ability, but we cannot make decisions simply on the basis of test scores alone. The high school record and standardized test scores (SAT Reasoning Test or ACT with Writing and SAT Subject Tests) work together to make up the academic portion of a student’s evaluation.

Carnegie Mellon is an exciting campus because of the positive qualities and experiences our students bring with them. For this reason, we’re interested in the kinds of things students do beyond the classroom, whether they participate in extracurricular activities, work part-time or pursue hobbies.

Knowing what students like to do on their own time gives us a feeling for each student’s personality, motivation and sense of responsibility. All of this is an important part of the admission process.

Expressing an interest in learning more about Carnegie Mellon can only enhance a student’s application. We strongly recommend that students come to the Carnegie Mellon campus to interview with a member of our staff, although it’s not required. This adds a personal touch to our evaluation and gives students a chance to ask questions. If you cannot make it to campus, consider talking with a local Carnegie Mellon alumni representative. There are a number of other ways to show interest and learn more about Carnegie Mellon. Students can come to one of our Sleeping Bag Weekends, attend an information program in or near their town, interview in their hometown with one of our staff members or alumni, or enroll in one of our summer programs. Information about a number of these events is included at the end of this section.

Different Criteria for Different Colleges
Each college at Carnegie Mellon has special admission criteria specifically related to each course of study.

Admission to the Schools of Drama and Music is based primarily on an audition or portfolio showing. Applicants to the Schools of Art and Design will be evaluated not only on the basis of their portfolio but also on their academic performance. Students applying to the School of Architecture are interested. You may apply to up to three colleges/programs. If applying to more than one college/program, rank your program and/or major preferences on the Carnegie Mellon Common Application Supplement. Be sure to meet the admission requirements for each college/program.

2. Follow these guidelines for your specific area of interest:
   • Carnegie Institute of Technology (CIT)
   • Dietrich College of Humanities and Social Sciences (DC)
   • Information Systems (IS)
   • Mellon College of Science (MCS)
   • School of Computer Science (SCS)
   • Tepper School of Business (Tepper)
   • Bachelor of Humanities and Arts (BHA) - see “BXA Intercollege Degree Programs” (p. 70)
   • Bachelor of Science and Arts (BSA) - see “BXA Intercollege Degree Programs” (p. 70)
   • Bachelor of Computer Science and Arts (BCSA) - see “BXA Intercollege Degree Programs” (p. 70)

Although you won’t declare a major until the end of your freshman or sophomore year (in some cases), Carnegie Mellon limits access to certain majors, including Electrical and Computer Engineering, Computer Science and Business.

• College of Fine Arts (CFA)

You must apply specifically to one of the following schools: Architecture, Art, Design, Drama or Music. (See specific instructions to follow.)

3. Submit the non-refundable $70 application fee (and audition fees if applicable).

We require this fee of all applicants except in extenuating family financial circumstances. A College Entrance Examination Board Application Fee Waiver, an ACT Application Fee Waiver, or a letter from a secondary school counselor or principal requesting an application for a waiver must be submitted.

If you are applying to the School of Music, the additional audition fee is $50 and if you are applying to the School of Drama the additional audition fee is $85 and only payable online by VISA or MasterCard, at the time of registering your audition online at www.cmu.edu/admission/application.

4. Request that your secondary school counselor send all high school transcripts, including senior year courses and mid-year grade, as well as a school profile to the Office of Admission as close to January 1 as possible.

5. Take the SAT Reasoning Test or ACT with Writing and SAT Subject Tests preferably by November, but no later than December. If you are applying to art, design, drama or music, SAT Subject Tests are not required.

• Scores must be official scores from the Educational Testing Service (ETS). Copies should not be sent. When registering for the tests, request than an official Score Report be sent directly to Carnegie Mellon. This request can also be made later by getting an Additional Report Request Form from your guidance office. The Carnegie Mellon code is 2074.

• Register for your tests at least six weeks prior to the test date.

6. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) should be taken if your native language is not English. Carnegie Mellon requires 102 or better on the IBT TOEFL, and an IELTS scores of 7.5 or above. Please arrange to have these scores sent no later than January 1.

7. If you are applying to the College of Fine Arts’ Schools of Art, Design, Drama, or Music, you must complete portfolio review or audition requirements. If you are applying to the School of Architecture, you are required to complete an online questionnaire and encouraged...
to submit a portfolio of creative work. Please go to www.cmu.edu/admission/finearts for further information. The Schools of Art, Architecture, Design and Drama requires that students apply to the university before registering for an audition or portfolio review. There is no Early Decision consideration given for the acting, directing, music theatre, composition, flute, music and technology, piano, violin, voice, or the BXA programs.

8. You must sign the “Confidentiality Statement” on the Common Application School Report Form and give it to your secondary school counselor for completion. Your counselor should return this form, along with the school profile and your transcript.

9. Choose a teacher to complete the Common Application Teacher Recommendation Form and make sure it is submitted to the Office of Admission by January 1 (November 1 or December 1 for Early Decision candidates).

10. Our Regular Decision application deadline is January 1. The College of Fine Arts Regular Decision deadline is December 1.

11. If you are applying for financial aid, complete a Free Application for Federal Student Aid (FAFSA) at http://www.fafsa.gov. Carnegie Mellon’s Title IV code is 003242. You must also complete the CSS PROFILE at https://profileonline.collegeboard.com and submit signed copies of parent and student tax documents. See www.cmu.edu/admission for more details.

Application Notification

• Students applying under the Early Decision I Plan will be notified of our decision by December 15.

• Students applying under the Early Decision II Plan will be notified of our decision by January 15.

• Students applying under the Regular Decision Plan will be notified of our decision by April 15.

• Students who are applying for financial aid will also receive financial aid decisions by April 15 provided they submitted their financial aid forms by the preferred financial aid deadline of February 15.

If you are offered admission and wish to enroll at Carnegie Mellon, you are required to pay an $800 non-refundable enrollment deposit by May 1 (Candidate’s General Reply Date), even if you are receiving financial aid, in order to reserve places in the freshman class and in university housing. This deposit will be credited to your first semester’s charges. The admission staff assumes that a student’s deposit to Carnegie Mellon is his or her only deposit. We reserve the right to cancel our offer of admission if a student posts a tuition deposit at another university. During the summer, information concerning registration, enrollment, insurance, orientation, housing and dining services, etc., will be sent to all students.

Deferred Admission

If you are admitted to Carnegie Mellon and wish to defer your admission for one year, you must submit a request in writing to the Office of Admission. If permission is granted, your enrollment deposit must be paid in order to confirm enrollment for the following year. You cannot enroll in a degree program at another institution in the interim.

Application Plans

Early Decision Plans

If Carnegie Mellon is your first choice, you may want to consider applying Early Decision. Under this plan, applicants are notified of our admission decision early in the senior year. If you are accepted Early Decision, we encourage you to enroll in Carnegie Mellon. Under the Early Decision plans, we encourage you to submit applications to other schools. However, if you are accepted to Carnegie Mellon, we require you to withdraw your applications from other schools.

Carnegie Mellon will meet the full demonstrated need with a combination of grants, loans and work-study as calculated by the university for all students admitted under Early Decision. However, we do not guarantee to meet full need for students who are deferred or denied admission under Early Decision and later admitted under Regular Decision.

Early Decision I is available to all programs, with the exception of acting, music theatre, directing, composition, flute, piano, music and technology, piano, violin, voice or the BXA programs. Early Decision II is available to all programs, with the exception of architecture, art, design, drama, music or the BXA programs.

Early Decision I Applications are due November 1 and students will be notified of an admission decision by December 15. Early Decision II applications are due by December 1 and students will be notified of an admission decision by January 15. If you are admitted under Early Decision, you are required to withdraw all admission applications to other colleges or universities and post a non-refundable enrollment deposit of $800 within two weeks of your admission notification.

Regular Decision Plan

Regular Decision is our most popular application option. The deadline is January 1 (December 1 for fine arts applicants). You will be notified of our decision by April 15. Admitted students will have until May 1 (Candidate’s General Reply Date) to accept our offer of admission.

Early Admission

Through the process of Early Admission, the university admits certain highly qualified applicants at the end of their junior year in high school. In general, Early Admission candidates are highly mature and responsible students who have usually exhausted the courses offered at their high schools without receiving a high school diploma. We expect students who apply for early admission to follow the same procedures as regular freshman applicants. We also strongly encourage applicants to have a personal interview with a member of the Office of Admission staff. It is important to note that the College of Fine Arts very rarely accepts Early Admission applicants.

Transfer Applicants

Transfer students are admitted to Carnegie Mellon under policies which vary from college to college. If there is space in the requested program, we will base our decision on your college grades, college recommendations, high school grades and test scores (SAT Reasoning Test or ACT with Writing and SAT Subject Tests, if available). In the College of Fine Arts, most transfer applicants compete with freshman applicants for a place in the entering class.

Transfer Application Instructions

1. Apply for admission to the specific college of interest, noting departmental preference. If interested in music or drama, student should specify the option. Transfer students will be considered only to their first-choice college. Please do not apply to more than one college.

2. CIF, DC, IS, MCS, or SCS:

   • Fall transfer possible if space is available
   • Spring transfer extremely limited and unlikely
   • No external transfers accepted into BHA/BSA/BCSA

   CPA:

   • Fall transfer possible
   • No spring transfer opportunities (except for advanced students in the School of Music)
   • If you are interested in the School of Music or Drama, specify the option
   • No external transfers accepted into BHA/BSA/BCSA

   The Tepper School of Business does not accept transfer applications.

2. Enclose a non-refundable fee of $70 (and audition fees if applicable). This application fee is required, except in extenuating family financial circumstances.

3. Send all transcripts that reflect secondary school and college/ university studies to the Office of Admission. We also require a copy of course descriptions from a college catalog from each college/university you attended. Course descriptions should be sent by email to mailto:undergraduate-admission@andrew.cmu.edu with the subject line “Transfer Course Descriptions.” Course descriptions should be copied and pasted into a single .doc or .pdf document, and must have your name and address on the first page.

IMPORTANT: If you have applied to Carnegie Mellon within the past three years, you must resubmit an updated application with fee (and audition fee if appropriate) and all other materials required of transfer students. You do not have to submit high school records.

4. If you are applying to the Schools of Architecture, Art, Design, Drama or Music, you must complete any portfolio or audition requirements.

   You must complete and submit the application for admission by December 1.

5. If you are interested in the School of Music, you must complete any portfolio or audition requirements.

   You must complete and submit the application for admission by December 1.

6. Transfer application deadlines are as follows:

   • Spring transfer: October 15
   • Fall transfer: March 1 (December 1 for CPA applicants)

7. If you are applying for financial aid, complete a Free Application for Federal Student Aid (FAFSA) at http://www.fafsa.gov. Carnegie Mellon’s Title IV code is 003242. You must also complete the
If planning on:  
Spring transfer: November 1  
Fall transfer (CFA): February 15  
Fall transfer (all other colleges): May 1

IMPORTANT: If you are applying for financial aid as a transfer student, you must send a Financial Aid Transcript of aid applied for and/or received for all colleges previously attended. Even if you didn’t receive any aid, federal regulations require that the college(s) attended complete the form.

Admission and financial aid award notification dates for transfer students:

Spring transfer: December 15 or soon after  
Fall transfer(CFA): April 15  
Fall transfer (all other colleges): During month of June

8. Make arrangements to have a final copy of your college transcript(s) sent to Carnegie Mellon.

Deposit Information for Transfers

If you are offered admission for the spring semester, Carnegie Mellon does not require a tuition deposit (due to the short time interval between December 15 and the start of the second semester). If you are offered admission to the College of Fine Arts for the fall semester, you must pay a non-refundable deposit of $800 by May 1, even if you are receiving financial aid. If you are offered admission to CIT, DC, IS, MCS, or SCS for the fall semester, you must pay a non-refundable $800 deposit by June 15, even if you are receiving financial aid. The enrollment deposit will reserve your place at the university and a place in university housing if available. It will be credited to the first semester charges.

IMPORTANT: If you accept our offer of admission, Carnegie Mellon assumes that the tuition deposit to Carnegie Mellon is your only tuition deposit. We reserve the right to cancel our offer of admission if you post a tuition deposit at more than one university. Enrollment deposits received after the deadline may be refunded if space is no longer available.

University Housing for Transfers

Carnegie Mellon expects to accommodate most transfer students who request university housing. University housing is not guaranteed, however, for transfer students. The Off-campus Housing Advisory and Referral Service is available to help you locate housing accommodations in the local area.

Transfer Credit Evaluated on Individual Basis

Carnegie Mellon’s departmental faculty will determine transfer credit for courses you’ve taken at other universities. Transfer credit is considered on an individual basis. We may award elective credit for courses with no Carnegie Mellon equivalent. In some instances, the College Council may recommend a special program of study for you to meet the university’s graduation requirements.

Transfer credit for courses you are taking while we review your existing college record depends upon successful completion of each course. Grades are not transferred – only credit is. You may receive transfer credit for elective courses you’ve taken but will still have to take Carnegie Mellon courses to fulfill the elective space in your chosen degree program.

If you transfer into CIT, IS, MCS, or SCS in the Fall semester, you will receive an estimate of the additional academic work that you must complete in order to fulfill the university degree requirements. If you transfer into CIT, IS, MCS or SCS in the Spring semester, you will have the opportunity to meet with a dean or department head in order to outline the additional academic work that you must complete in order to meet the university degree requirements. If you transfer into DC in the fall or spring semester, you’ll receive a credit and requirement review of the work you’ve completed at your previous institution(s). It is best for transfer students in CFA to assume freshman status. Occasionally advanced standing is awarded based on review of previous college courses.

Application as an International Student

International students should apply to Carnegie Mellon using the same procedures outlined for either freshmen or transfer students. Also note this additional information:

- Before submitting the Common Application and Carnegie Mellon Supplement, and other application materials, please submit the Preliminary Application for International Students at http://my.cmu.edu/portal/sit/admission/pre_app/. Because Carnegie Mellon does not offer financial aid or installment plans to international students, we use this application to verify each student’s ability to pay for a Carnegie Mellon education. International students are not eligible for application fee waivers.
- If your native language is not English, you are required to take the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS). Carnegie Mellon requires 102 or better on the iBT TOEFL or an IELTS score of 7.5 and above. Please arrange to have these scores sent no later than January 1.

Advanced Placement Consideration

Advanced Placement Program

Carnegie Mellon recognizes the Advanced Placement program and may grant advanced placement and credit for test scores of four or five. We encourage eligible students to take the AP examinations. We will receive the test scores in early summer for those students who have requested that their results be sent to Carnegie Mellon. The appropriate academic dean will evaluate your scores, and in late summer, you will be informed of the AP credit awarded.

College Level Course Work

The university may also award placement and credit for college work completed during high school. Applicants who have taken college courses should arrange to have their college transcripts along with course catalogs or descriptions sent to the Carnegie Mellon Office of Admission for transfer credit evaluation and advanced placement.

International Baccalaureate Program

Carnegie Mellon also recognizes the International Baccalaureate Examination and may grant advanced standing and/or credit in various fields if scores on the higher level examination range from six and seven. The results of the IB exams should be sent to Carnegie Mellon, where the appropriate dean will evaluate the scores. In late summer, you will be notified of the credit that has been awarded.

BXA Intercollege Degree Programs

Bachelor of Computer Science and Arts (BCSA)

The Bachelor of Computer Science and Arts (BCSA) Program is an intercollege degree-granting program. It is designed for students who would like to combine their interests in the fine arts and computer science rather than pursue a conventional major and degree in either the College of Fine Arts (CFA) or the Dietrich College of Humanities and Social Sciences (DC). To be considered for the BCSA program, you must apply and be admitted to both CFA and SCS (you must check the CFA box and SCS box on the Carnegie Mellon Common Application Supplement). This program is only open to directing and production technology and management for Drama and composition and music technology for Music. Not all students admitted to both colleges are selected for the BCSA program.

Bachelor of Humanities and Arts (BHA)

The Bachelor of Humanities and Arts (BHA) program is an intercollege degree-granting program. It is designed for students who would like to combine and blend their interests in fine arts and humanities/social sciences rather than pursue a conventional major and degree in either the College of Fine Arts (CFA) or the Dietrich College of Humanities and Social Sciences (DC). To be considered for the BCSA program, you must apply and be admitted to both CFA and DC (you must check the CFA box and DC box on the supplement). This program is not open to music theatre or acting majors. Not all students admitted to both colleges are selected for the BHA program.

Bachelor of Science and Arts (BSA)

The Bachelor of Science and Arts (BSA) program is an intercollege degree-granting program. It is designed for students who would like to combine studies in both the fine arts and natural sciences/mathematics rather than pursue a conventional major and degree in either the College of Fine Arts (CFA) or the Mellon College of Science (MCS). To be considered for the BSA program, a student must apply and be admitted to both CFA and MCS (you must check both the CFA box and MCS box on the supplement). This program is not open to music theatre or acting majors. Not all students admitted to both colleges are selected for the BSA program.
another essay. If you are selected for this program, you will be notified in your admission decision letter. These programs are not available under Early Decision.

College of Fine Arts Requirements

Deadlines

• Early Decision applicants must submit a complete admission application, including any required artistic evaluation, by November 1 (Drama applicants must meet this deadline if they choose the November audition date).
• Regular Decision applicants must submit a complete admission application by December 1 and all audition or portfolio review reservations should be made before this date.

Communication of Information and Admissions Decisions

• Once you have registered for the appropriate audition or portfolio review at http://www.cmu.edu/admission/finearts, you will receive further instructions from us via email.
• Final admission decisions are not made at the time of your audition or portfolio review. We will consider the artistic evaluation as part of your application along with your other credentials and notify you by April 15 (December 15 for Early Decision applicants).

Please visit http://www.cmu.edu/admission/finearts for details regarding the specific requirements for fine arts auditions and portfolio reviews.

Exploring Carnegie Mellon

Visiting a campus is one of the best ways for you to discover which school is right for you. We strongly recommend that you attend an information session or interview with a member of the admission staff while on campus. Admission interviews allow us the opportunity to get to know our applicants. Interviews are considered in the admission process and help the admission committee make better, more informed decisions with determining the freshman class. During the interview, you’ll have the opportunity to ask questions about admission requirements, financial aid, student life, Pittsburgh - and much more!

On-campus auditions and portfolio reviews usually include an interview with a member of the Fine Arts faculty and a campus tour. Therefore, only one campus visit is necessary for fine arts students.

Campus Tours

Campus tours are conducted by Andrew Ambassadors and leave from the Office of Admission, 101 Warner Hall. On most weekdays during the academic year, we conduct four tours daily at 9:30 a.m., 11:30 a.m., 1:30 p.m., and 3:30 p.m., as well as a residence hall visit at 11:00 a.m. and 1:00 p.m. Saturday tours and group sessions are held throughout the year as well. Tours may not be available during university holidays, vacations or final exam periods in mid-December, late March, mid-April and early May. To be sure a tour is available on the day you’re coming to the campus, please call 412-268-2082.

Hometown Interviews

Although we strongly recommend a campus visit, we realize that it is not always possible for you to come to campus. The Admission staff does travel to various parts of the country interviewing students in their hometowns. Information about making an appointment will be mailed to students prior to the time we arrive in your city. Students who interview on campus do not have to schedule another interview in their hometown. The specific dates and locations for Hometown Interviews are listed online at www.cmu.edu/admission.

Alumni Interviews

We encourage students to talk with a member of the Carnegie Mellon Admission Council (CMAC). CMAC, a select group of alumni, helps the Admission staff reach out to prospective students. Alumni interviews are as valuable when making admission decisions as interviews with the Admission staff. If you’re interested in interviewing with a member of CMAC, please visit http://my.cmu.edu/portal/site/admission/alum_interviews/.

Sleeping Bag Weekends

The more information you have, the better decisions about college you’ll make! The Admission staff invites you to learn more about Carnegie Mellon by living like a university student for a day and a half in our Sleeping Bag Weekend program. Visits begin on Sunday morning and last through Monday afternoon.

Sleeping Bag Weekends give you the opportunity to learn everything you may want to know about Carnegie Mellon. The weekend activities allow you to:

• meet current students, faculty members, deans and admission counselors
• attend information sessions about the university and specific programs
• stay overnight in a residence hall
• tour the campus
• attend classes
• at at the dining facilities

There are four Sleeping Bag Weekends in the fall and winter. If you are on our mailing list, you should receive an invitation in the early fall. To reserve a place at a Sleeping Bag Weekend, visit www.cmu.edu/admission/sbw.

Information Sessions

The Office of Admission offers two different information sessions throughout the year, both on and off campus. Carnegie Mellon Preview Sessions, offered in the Spring, are meant for freshmen, sophomores and juniors in high school, who are looking for a general overview of the college search process. Carnegie Mellon’s Information Sessions for High School Seniors, available in the Summer and early Fall, offer an in-depth look at the university. During the informational program, you’ll have the opportunity to learn more about Carnegie Mellon’s areas of study, the admission process and admission requirements, how to apply for financial aid and our campus and alumni through exciting video testimonials. Check out the schedule and register at http://my.cmu.edu/portal/site/admission/counselors/.

Call Carnegie Mellon for Assistance

If a student will need assistance while visiting the campus, due to a physical or learning disability, he/she should call us at 412-268-2082, and we will help meet the student’s needs during his/her visit at Carnegie Mellon.

Directions to Campus

Directions to Carnegie Mellon’s campus from the north, east, south, west and the airport are available at http://my.cmu.edu/portal/site/admission/travel. Please call (412) 268-8343 to listen to a recorded message of these directions to campus by phone. If you are using a GPS, the following address will take you to the East Campus Parking Garage: 5040 Forbes Avenue, Pittsburgh, PA 15213.
Summer Opportunities

The campus is in full operation during the summer, populated by students and faculty from a variety of programs. The university continues to have outstanding, innovative educational programs extending beyond regular involvement with its degree candidates. Six such programs are offered during the summer for high school students: the Pre-College Programs in the Fine Arts (Architecture, Art, Drama and Music), the Advanced Placement Early Action Program and the Summer Academy for Mathematics and Science. Three sessions of summer school are held for college students who wish to make up or advance their degree program studies. Every service and support organization is available to summer students: the Computer Center, the Health Center, the Counseling Center, the libraries, the Office of Admission, the Career Center, Student Activities, etc.

Summer Pre-College Programs for High School Students
Office of Admission, Warner Hall 2nd Floor

The Pre-College Programs are designed to preview an actual college experience. Our programs afford high school students many opportunities for personal growth and development within a university setting. A wide range of social, cultural, and recreational activities are planned by a staff of resident counselors to fully integrate the students' lives on campus and in Pittsburgh. Movies, dances, museum and gallery visits, field excursions or attendance at professional theater productions, concerts, and Pittsburgh Pirates games are just a few of the sponsored activities.

Summer Academy for Mathematics and Science

Students with diverse backgrounds who are entering their junior or senior year and considering careers in engineering, science and other math-based disciplines are eligible to participate in this rigorous program. Traditional classroom instruction, along with creative "hands-on" projects will allow students to apply concepts and principles.

Advanced Placement Early Admission Program

The main purpose of the Advanced Placement Early Admission (AP/EA) Program is to provide the opportunity to take university courses at Carnegie Mellon for talented, motivated high school students. Students earn college credit while working in an academic environment mirroring that which the student would encounter during the first year of college.

Students who complete two courses in the AP/EA Program and who can graduate early from high school have the unique opportunity to apply Early Admission. By attending the AP/EA program during the summer of 2012, students who will be high school juniors in the fall of 2012 will have a strong understanding of college life and academics. These rising juniors are eligible to apply Early Admission by January 1, 2013, and if accepted can start as full-time degree students here in the fall of 2013. Students admitted under Early Admission are not obligated to accept the offer of admission until May 1.

All AP/EA students may also apply to Carnegie Mellon during their senior year, through Early Decision (various deadlines in November and December depending on the college) or Regular Decision (January 1 deadline, or December 1 for the College of Fine Arts).

Regardless of whether students choose to apply to Carnegie Mellon, successful AP/EA students can leverage their experiences here as demonstration of their ability to succeed in college. AP/EA courses are college courses, not AP classes, and as such they count toward graduation requirements here and are widely accepted elsewhere. Students applying to another college or university can request an official Carnegie Mellon transcript be sent to that institution. Any use of AP/EA courses to satisfy high school requirements should be approved ahead of time by an appropriate high school official.

While most of the participants in the program will have just completed their junior or senior year of high school, suitably qualified students at early grade levels can participate. However, in order to stay in university housing, students must be at least 16 years old. However, this does not apply to commuters.

AP/EA Coursework

Our AP/EA courses are regular Carnegie Mellon classes, so you should anticipate intense, college-level work. Many of the AP/EA faculty members are the same faculty who teach during the regular school year. Upon admission to the program, students will select their courses from the Schedule of Classes. View the 2012 AP/EA course list (http://www.cmu.edu/enrollment/pre-college/apea12.pdf).

*Please see the AP/EA course addendum (http://www.cmu.edu/enrollment/pre-college/APEA_addendum3.12.pdf) for additional information, revised as of 3/13/2012.*

As an AP/EA student, you’ll be required to take two courses during the summer. This two-course schedule completed in six weeks is comparable in demand to the typical five-course schedule completed in a semester.

The flexible AP/EA program allows you to take:

- Two math/science/engineering courses
- One math/science/engineering course and one humanities/social sciences course
- Two humanities/social sciences courses

Some features of the AP/EA classes include:

- daily meetings
- small class size
- personal learning environment
- supplemental tutoring
- instruction by faculty selected for their enthusiasm and experience teaching college-level material to younger student

Pre-Requisites

High school preparation is necessary for some AP/EA classes. For more details, consult the course descriptions or contact the program director.

- **Calculus requires:**
  - Algebra, trigonometry and geometry. Pre-calculus or an equivalent course is recommended.

- **Computer science requires:**
  - Knowledge of computers or some computer experience in high school is helpful but not required. PSAT Math of 65 or higher, or SAT Math of 650.

- **Physics, chemistry and biology require:**
  - Students enrolled in physics, chemistry, biology or engineering must have completed a physics, chemistry or biology high school course.

Students with special qualifications may apply for permission to enroll in a third course with an additional non-refundable charge. Carrying three courses in the AP/EA program is not generally recommended.

Pre-College Architecture Program

The Pre-College Architecture Program is an opportunity for those high school students who have completed their junior year to discover whether they have the necessary aptitudes for further study at the college level. The students learn the nature of professional training, discover if they enjoy this type of concentration and most importantly, realize the degree of their individual talents. At the conclusion of the period of study, each student's work is evaluated indicating the level of aptitude in this field.

The program is divided into three components which occupy the entire day. In the morning, students attend lecture-style courses covering a range of topics, including architectural history, technology, and the architecture profession. Students will attend drawing classes, teaching both hand-drawn and computer drawing techniques. These are introductory courses, assuming no prior experience.

Each afternoon, students meet for design studio. The studio is a hands-on environment, challenging students to design solutions to given spatial problems. This course teaches fundamental design skills, modelmaking and drawing craft, critical thinking, and creative speculation.

Field trips will be to local cultural institutions, construction sites, and to local architecture firms.

At the conclusion of the program, the student will receive a private consultation with faculty, as well as a written letter of evaluation on the student’s progress and aptitude.
Pre-College Art Program
Carnegie Mellon is a place where creativity grows. Learn more about yourself and the world while making art and making friends. Combine your visions with passion and discipline and make art that matters.

The Pre-College Art Program motivates, stimulates and prepares you as an emerging artist. Exploring traditional tools and new technologies in a variety of media leads you to develop conceptual and technical skills as well as your portfolio—all excellent preparation for applying to and succeeding in college-level art programs. Challenging lectures and courses, museum and gallery field trips, and energetic interaction with dedicated faculty and talented peers immerse you in the spirit and substance of an art school culture and environment.

An array of events and opportunities combine to enrich your studio work including: visits to the Carnegie Museum of Art, the Andy Warhol Museum, the Mattress Factory (installation museum), including: gallery and field trips, and energetic interaction with dedicated faculty and talented peers immerse you in the spirit and substance of an art school culture and environment.

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You choose a schedule of Core and Mini Studios. Core Studios include: Drawing, Painting, Animation, Sculpture and Comic Book/Serial Imagery. Mini Studios Include: Printmaking, Ceramic Sculpture, Head Studies and Digital Photography.

A written evaluation of your artwork is provided at the end of the summer.

Pre-College Drama Program
Carnegie Mellon’s drama program has an innovative and dynamic history that has produced graduates in every branch of theater, film, television and video.

If you’re a serious theater student, or debating whether to become one, you can come here with a good deal of experience or almost none at all, as long as you come ready to work hard and learn.

A Carnegie Mellon summer is a rich and exciting experience. The Pre-College program focuses on creative growth and preparation for actors, musical theater students and technical apprentices. Carnegie Mellon Drama faculty members will coach you, evaluate your work and help steer you into compatible studies, whether those studies take place at Carnegie Mellon or elsewhere. Outstanding students have a possibility of fulfilling the talent portion of our admission process through this program.

Pre-College Music Program
Carnegie Mellon’s School of Music is a stimulating, vibrant place where talented young performers, composers and conductors prepare for professional careers in music. At Carnegie Mellon, tradition and technology coexist. Building upon 75 years of excellence as a conservatory, turning out superb musicians who are known throughout the world as performers, composers, conductors and teachers, the School has become a leader in the field of computer music. New state-of-the-art computer music facilities challenge the most adventurous young musicians to learn more about acoustics and discover new sounds. Music theory software, developed at Carnegie Mellon, enhances the curriculum, and the finest composition software on the market is available to assist the young composer in creating new music. Expert instruction in sound recording provides yet another opportunity for young musicians interested in broadening their musical base. At Carnegie Mellon students are taught to appreciate, to understand, and to perform the music of the past, yet they are also expected to be comfortable with the innovative sounds of the future.

Becoming a professional musician requires extraordinary talent and versatility. The complete musician must be prepared to play jazz as well as classical and contemporary repertoire. Therefore, at Carnegie Mellon a full program of jazz studies is available to enhance the conservatory training. Singers learn to act, to dance, to perform in several languages. Composers learn to conduct, to prepare orchestral scores, to rehearse their own works. Pianists are expected to sight read, play chamber music, accompany singers, and play synthesizer. Music at Carnegie Mellon is more than practicing an instrument—it is an intense, exciting course of study, experienced side by side with other young musicians who share the same goals and aspirations.

The six-week Summer Music Program offers a unique taste of the life of a student musician at Carnegie Mellon in a low pressure environment of study and performance. This is an ideal opportunity to discover your potential for a career in music. Within the rich cultural life of the city of Pittsburgh and the varied activities on the Carnegie Mellon campus, the Summer Program is an extraordinary way for a young musician to spend the summer.

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National High School Game Academy
The National High School Game Academy (NHSGA) is an intensive study of video game design and development. This six-week program includes an exciting blend of hands-on exercises combined with traditional lecture and discussion. If you are interested in exploring the world of video game development, the NHSGA may be for you!

Modeled after Carnegie Mellon’s graduate program in Entertainment Technology and corporate sponsored by Electronic Arts, the NHSGA is structured to give students a taste of the current state of video game development and guidance towards embarking on their own career in the video game industry.

Students are encouraged to expand their creativity in a unique blend of left- and right-brain college-level work. Students will be encouraged to pursue undergraduate studies in software engineering, design, creative writing or dramatic arts after the program after gaining an understanding of how their education can lead to a career in the interactive digital media field.

Requests for applications and further information should be addressed to:

Pre-College Programs
Office of Admission
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
(412) 268-2082
FAX: (412) 268-7838
Division of Enrollment Services

Lisa Krieg, Director of Enrollment Services
Office: Warner Hall A19, 5000 Forbes Avenue Pittsburgh, PA 15213-3890
http://www.cmu.edu/hub

The Division of Enrollment Services includes five administrative departments: The HUB, University Registrar’s Office, Student Financial Aid, Student Accounts Office and Campus Affairs Systems. The division leads and delivers integrated administrative services that support students’ academic goals from enrollment through graduation. At the same time, the staff strives to champion collaborative administrative services and counsel for all CMU campuses and programs in alignment with the university’s strengths in technology and effectiveness.

2012–2013 Cost of Attendance

The budgets depicted below reference a typical Resident, Commuter or Off-Campus Student. The university reserves the right to change its charges without notice.

The academic year tuition charges are for all full-time undergraduate students. A full-time student is one registered in a degree program and carrying a schedule of at least 36 units per semester. A student enrolled for less than 36 units per semester will be charged tuition on a per-unit basis.

Note: All incoming freshmen are required to live on campus. Permission to live off-campus must be granted by Student Affairs.

Freshmen - Fall 2012
Per-unit tuition rate: $623

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Undergraduate students who entered Fall 2011
Per-unit tuition rate: $617

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Undergraduate students who entered Fall 2008, 2009, 2010
Per-unit tuition rate: $611

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<td>360</td>
</tr>
<tr>
<td>Room &amp; Fees (2)</td>
<td>6,810</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dining (1)</td>
<td>4,430</td>
<td>2,380</td>
<td>2,380</td>
</tr>
<tr>
<td>Books/Supplies &amp; Miscellaneous (3)</td>
<td>2,400</td>
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<tr>
<td>Transportation Allowance (3, 4)</td>
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<tr>
<td>Totals</td>
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Undergraduate students who entered Fall 2007
Per-unit tuition rate: $600

<table>
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<tr>
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<th>Resident</th>
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<tbody>
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<tr>
<td>Activity Fee</td>
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<td>194</td>
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<tr>
<td>Port Authority Fee</td>
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<tr>
<td>Media Fee</td>
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<tr>
<td>Technology Fee</td>
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</tr>
<tr>
<td>Room &amp; Fees (2)</td>
<td>6,810</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dining (1)</td>
<td>4,430</td>
<td>2,380</td>
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<tr>
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<tr>
<td>Transportation Allowance (3, 4)</td>
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<td>680</td>
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<tr>
<td>Totals</td>
<td>$57,530</td>
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Undergraduate students who entered Fall 2006
Per-unit tuition rate: $578

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<tr>
<td>Transportation Allowance (3, 4)</td>
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<tr>
<td>Totals</td>
<td>$55,922</td>
<td>$47,742</td>
<td>$55,922</td>
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</table>

Footnotes:

1. The commuter dining amount is based upon 14 meals per two weeks.
2. Off-Campus room rate is resident room minus $500.
3. These expenses will not appear on your Student Account Invoice.
4. Transportation for resident and off-campus students varies based on home state.

Health Insurance

In addition, minimal health insurance coverage is required at an estimated cost of $1,043/year, unless a waiver is granted because you are covered under your family’s health plan. Enhanced health insurance coverage is suggested for international students at an estimated cost of $2,544/year. Complete information about the university’s Health Insurance Policy and options, as well as the waiver requirements, is available at www.studentaffairs.cmu.edu/HealthServices/insurance.

The HUB

Brian Fernandes, Associate Director of Enrollment Services
Office: Warner Hall A12, 5000 Forbes Avenue Pittsburgh, PA 15213-3890
Phone: (412) 268-8186
Fax: (412) 268-8084
E-mail: thehub@andrew.cmu.edu

The HUB staff delivers comprehensive service and counsel to students and families regarding financial aid, billing and payment, registration, academic records, and ID Card services. In direct support of student enrollment and persistence, The HUB offers students and families highly integrated information through personal attention and technologically responsive tools in a professional, forward-thinking, and accessible environment.

The Assistant Directors in The HUB serve as contacts for specific colleges and assist enrolled students with key aspects of the enrollment process – financial aid, billing and registration. Contact information for assigned HUB Assistant Directors can be found on The HUB website (http://www.cmu.edu/hub/hours.html). Assistant Directors can be contacted for specialized enrollment questions.

For general questions and information, please e-mail thehub@andrew.cmu.edu or call (412) 268-8186 during regular office hours: Monday, Wednesday, and Friday between 8:30 a.m. and 4:30 p.m. or Tuesday and Thursday between 10:30 a.m. and 4:30 p.m.
University Registrar’s Office

John Papinchak, University Registrar
Fax: (412) 268-6651
E-mail: university-registrar-office@andrew.cmu.edu

The University Registrar’s Office (URO) performs the essential roles of administering the collection and maintenance of student records, ensuring their accuracy and integrity, and enforcing academic policies while providing the best possible services. The URO aspires to provide exceptional, environmentally-conscious services, while anticipating and meeting growing customer requirements with innovative processes, training and self service applications. The office strives to foster and promote an environment of professional development and appreciation.

The University Registrar’s Office produces a complete calendar of important dates and deadlines for the academic year, which can be found on the HUB website, http://www.cmu.edu/hub.

Undergraduate Enrollment

Enrollment is the process whereby eligible students notify Enrollment Services that they will be attending the university by registering for courses and selecting their class accounts. Enrollment must be completed before students may begin classes and before they may utilize university facilities.

Complete information about the enrollment process, as well as registration and payment deadlines, are listed on the Official Academic Calendar, located on The HUB Website, www.cmu.edu/hub.

Registration

Registration is the process of selecting courses for the upcoming semester and discussing those selections with an academic advisor. We strongly encourage you to meet with your academic advisor before you finalize your selections and register for courses using Student Information Online (SIO) (https://s3.as.cmu.edu/sio/#schedule-registration).

For most entering freshmen, registration is accomplished during the summer, with the assistance of Associate Deans and department heads. Academic placement and elective choice information is collected by mail questionnaires during June and July. Most freshmen receive their schedules and enrollment information prior to the first day of classes.

Currently enrolled students select their courses for the upcoming semester during Registration Week, prior to the end of each semester. The Schedule of Classes is available online prior to Registration Week, listing available courses along with general enrollment information. The university reserves the right to make changes to hours, units or instructional staff when such changes seem necessary or advisable. A link to the online Schedule of Classes is provided on The HUB website (http://www.cmu.edu/hub). Although faculty advisors are provided, it is the responsibility of students to have clearly in mind what they intend to do, what elective courses they wish to pursue and what irregularities exist which may affect their present schedule.

Students are not permitted to register in courses for which the prerequisites have not been satisfied. Exceptions to the rule may be granted only upon written request of students or students and department heads. Petitions for exceptions are reviewed by the academic department concerned. Unless the prerequisites are satisfied or special approval is obtained when the student enters the course, no credit can be allowed for the course.

Tuition Assessment

The tuition charged each student will be automatically adjusted on the 10th regularly scheduled class day (refer to the specific date noted in Official University Calendar as the “last day to add courses”) based upon each student’s schedule at that time. The tuition charged will be increased whenever the number of units added justifies tuition charged greater than those paid by the student at the time of fee settlement. After that time, no tuition adjustments will be made, except the exception of second minus for that particular semester.

For additional information, see University Policies (p. 24).

PCHE Cross-Registration

Cross-College and University Registration Guidelines - PCHE (Pittsburgh Council on Higher Education)

Cross-registration provides opportunities for enriched educational programs by permitting full-time paying undergraduate and graduate students to cross register for one course at a Pittsburgh Council on Higher Education (PCHE) Institution. Students who are paying full-time Carnegie Mellon tuition (per the requirements of their home college) are eligible. The PCHE course may not count towards full-time status. There is no additional tuition charge, except for special course or laboratory fees. Carnegie Mellon students do not acquire status at the Host Institution, but are given library and bookstore privileges. Credit and grades are transferred directly to the home institution. Cross-registration is not applicable during the Summer Session(s) or during intersessions.

For more information, visit http://www.cmu.edu/hub/registration/undergraduates/cross/

Faculty Course Evaluations (FCEs)

Students play an integral role in the academic life of the university when they participate in the evaluation of the faculty through the Faculty Course Evaluation process. FCE data is important in the evaluation of teaching and learning, as an important piece of the promotion and tenure process and as part of the process of course design and improvement. Student participation in the FCE process is critical to the university’s commitment to quality teaching and academic excellence. Students are strongly encouraged to participate in the process with constructive feedback that is relevant to teaching and course content. More information on the University Course Assessment process and results from previous years can be found at the FCE website (http://www.cmu.edu/hub/fce).

Student Financial Aid

Linda Anderson, Director of Student Financial Aid
http://www.cmu.edu/finaid/

In alignment with the university’s enrollment goals, Student Financial Aid consistently optimizes the utilization of all financial aid resources in order to recruit and retain a high quality and diverse student population. Student Financial Aid strives to deliver superior services that exceed the expectations of students, parents, and internal and external constituencies. Student Financial Aid identifies, creates and delivers strategies that facilitate the integration of financial aid policies. These policies align with current and future university recruitment, retention and enrollment priorities.

How Aid Works

Our financial aid program is need-based, meaning that all aid eligibility is determined by a student’s family’s financial circumstances. While a student and his/her parents have the primary responsibility for paying for college, financial aid can bridge the gap between the total costs and the family’s ability to pay.

We use a standard method to carefully review a family’s financial circumstances and establish an expected contribution from the student and parents. If we determine that the family cannot meet the student budget based on that calculated amount, we will award or recommend scholarships, grants or other resources.

For more information, visit http://www.cmu.edu/finaid/undergraduate/how.html.

Applying for Financial Aid

Complete steps for applying for financial aid can be found at http://www.cmu.edu/finaid/undergraduate/applying.html.

Types of Financial Assistance Available

There are several types of financial aid available to students, such as the following:

- Federal and Private Loans
- University Scholarships
- Outside Scholarships
- Federal and State Grants
- Student Employment

A full listing of these, as well as more information on each type, is available at http://www.cmu.edu/finaid/undergraduate/types.html.

Financial Aid Policies

University Academic Scholarship Renewals

Carnegie Mellon University awards academic scholarships as part of the freshman financial aid process. Each of these scholarships is renewable for four academic years of study (five for architecture) based upon the maintenance of a 2.0 cumulative quality point average. The academic scholarship renewal criteria are included in the scholarship notification letter which is mailed to the student prior to the May 1 matriculation deadline.

Each scholarship recipient’s cumulative quality point average is reviewed at the end of each academic year. If the student achieves the scholarship renewal criteria, then the scholarship is automatically renewed for the next academic year.

If the student does not meet the cumulative quality point average requirement for renewal, then s/he is given the opportunity to appeal. A
Undergraduate International Students

Documentation Eligibility (U.S. Citizenship or Eligible Noncitizen)

You must be a U.S. Citizen or Eligible Noncitizen to receive federal student aid. If you are a U.S. Citizen, but were not born in the United States, please send us documentation of your citizenship (e.g., a copy of your passport or naturalization certificate). If you are an Eligible Noncitizen or refugee, send us verification. Acceptable forms of verification include a photocopy of both sides of your I-551 or I-551C card.

Undergraduate international students are ineligible to receive any federal or state student financial aid. Additionally, Carnegie Mellon does not award any institutional financial aid funds to undergraduate international students.

Student Accounts Office

Brian Hill, Director of Student Accounts

The Student Accounts Office serves the university’s various academic and administrative departments by processing and invoicing all student-related financial activity and managing the corresponding student financial obligations resulting from this activity. The office strives to serve students by accurately reflecting and communicating these financial obligations, providing timely and consistent responses to inquiries, and instilling financial responsibility and accountability with clear and concise guidance.

Billing Information

University Charges

All charges incurred at the university are reflected on your student account. Charges include tuition and fees and may include housing, dining, sorority or fraternity charges, health insurance, Pfaid Cash, DineXtra and any miscellaneous charges incurred. Miscellaneous charges may include, but are not limited to, music lessons, library fines, parking fines, or emergency loans.

Student Account Invoices (E-Bills)

Student account invoices (E-Bills) are produced on the last day of each month. Invoices detail all transactions processed in the month, as well as any charges due in the future. Students receive an e-mail notification from the Student Accounts Office when a new E-Bill is ready for viewing on Student Information Online. Payments for amounts due from a monthly E-Bill must be received by the 15th of the next calendar month.

All student account invoices are available to view, print, or download through Student Information Online (SIO). Students can log onto Student Information Online (https://s3.as.cmu.edu/sio/#home) with their Andrew ID and password.

Billing Authorizations

Students can also authorize Carnegie Mellon to send a copy of their E-Bill to another individual (parent, spouse, etc.) or other individual bill payer’s e-mail address. After completing the authorization process, designated recipients will receive an e-mail with a PDF attachment of the E-Bill and any related billing messages.

Penalty Charges

Any amounts not paid by the stated due date are subject to a 1.5% penalty charge until the balance is paid in full.

Payment Options

Electronic Payments (E-Check)

The Student Accounts Office encourages you to take advantage of this convenient way to pay your student account. Electronic payments can be made online by registering a U.S. checking or savings account on Student Information Online (https://s3.as.cmu.edu/sio). Payments can be scheduled up to 6 months in advance and can be modified at any point before the requested payment date. This is the fastest, easiest, and most convenient way to make a payment to or receive a refund from the university. Best of all, this option is offered free of charge.

Check Payments via Mail:

When paying by check, please write your name and Andrew ID on the memo line of the check and include the bottom portion of page 1 of your most recent invoice.

Make checks payable to Carnegie Mellon University and send to our processing agency:

Carnegie Mellon
P.O. Box 360224
Pittsburgh, PA 15251-6224
Wire Transfer Payments
When making a wire transfer payment be sure to include the student’s full name and invoice number on the transfer. Wire payments to Carnegie Mellon can be initiated through most banks. The following information is required when sending a wire transfer payment:

Bank of New York Mellon
500 Ross Street
Pittsburgh, PA 15262

Account Name: Carnegie Mellon University
Routing Number: 043-000-261
Account Number: 197-9003
SWIFT Number: MELNUS3P
Reference: Student Name and Andrew ID

Foreign wire transfers take longer to process. Please allow sufficient time to avoid late payment fees.

If you call The HUB to inquire about receipt of funds, you must have the following information available at the time of your call. You may also need to provide additional details of the wire transfer.

• Reference Number
• Amount sent
• Student Name
• Date Sent (on the receipt)

Tuition Payment Plan
The Carnegie Mellon Tuition Payment Plan gives students the ability to pay amounts due to the University in convenient monthly installments. There are many benefits to this plan, to include life insurance. These benefits are paid for by a low annual enrollment fee. A semester option with a lower enrollment fee is available for students who graduate in December or who begin in the spring semester. Families who renew a payment plan for a subsequent academic year have the option of paying over 12 months rather than the standard 10 months.

The plan allows families the convenience to enroll and pay online. If a monthly payment plan is set up with TMS, contracted amounts will be credited to the appropriate semester invoice so the student’s bill reflects any additional amount due. Families have the flexibility of reducing or increasing their payment plan if a balance is due to the university or if there is a credit on the student’s account.

Benefits of the Carnegie Mellon Tuition Payment Plan include:

• Life Insurance coverage for the bill payer’s account
• Toll-free telephone service during extended personal service hours at 888-251-3533
• BorrowSmart counseling with friendly and professional Education Payment Counselors
• A wide variety of payment methods, including personal checks, money orders, credit cards, Western Union by wire or check, and automated payments from a checking or savings account
• 24-hour access to account information at www.afford.com/cmu (http://www.afford.com/cmu)
• 24-hour access to account information on a toll-free InfoLine

Enrolling in a payment plan may help to reduce the amount that students and their families borrow. TMS offers BorrowSmart planning and counseling at 888-251-3533 from 8 a.m. to 10 p.m. weekdays, and 9 a.m. to 3 p.m. on Saturdays.

Sponsor Checks & Scholarship Checks
Payments made by sponsors and/or scholarship agencies must be sent directly to the Student Accounts Office:

Student Accounts Office
Carnegie Mellon University
Warner Hall A19
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Refunding
Refunds
If a student account has a negative balance resulting from an overpayment, financial aid, or a reduction of charges, the Student Accounts Office will review the account and issue a refund. If you have a negative balance and do not want a refund to be generated, please contact The HUB so they can update your account.

Electronic Refunds
The Student Accounts Office encourages all students to authorize electronic deposit of their student account refunds directly into their U.S. checking or savings accounts. Taking advantage of this opportunity eliminates the need to stand in line at The HUB to pick up a refund check and makes the funds available to the student within two business days. To enroll, students simply need to add a bank account on Student Information Online (https://s3.as.cmu.edu/sio).

Paper Checks
If you have not signed up to receive electronic refunds, your refund will be generated as a paper check that must be picked up in The HUB. Students who are issued a paper check for a student account refund have six months to cash the check. If the check is not cashed within six months, it will be voided and credited back to the student account and applied to any outstanding charges.

ID Card Services
Office: The HUB, Warner Hall, 5000 Forbes Avenue Pittsburgh, PA 15213-3890
Phone: (412) 268-5224
Fax: (412) 268-8084
E-mail: idplus@andrew.cmu.edu

One of the most important items you will need at Carnegie Mellon is your official identification card. Your ID Card identifies you as a member of the Carnegie Mellon community. Your ID Card will be part of your everyday life on campus and is used to access the following:

• University Housing Residence Halls
• Computing Services & Computer Clusters/Labs
• University Libraries
• Local Port Authority Transit (bus, incline, etc.)
• Dining Services Meal Plans
• Computer Store
• University Center Retail Shops
• Athletic Facilities

For a full list of services that can be accessed using the ID Card, visit www.cmu.edu/idplus/services.

Plaid Ca$h
One beneficial feature of your ID Card is Plaid Ca$h. Plaid Ca$h is a prepaid, stored-value/debit account that is accessible via your ID Card. It is a convenient, cashless way to pay on and off campus. You can use Plaid Ca$h for textbooks, school supplies and laundry. Many of the area’s most popular businesses accept Plaid Ca$h; it can be used to pay for restaurant meals, take-out, delivery and more. View a list of participating businesses at www.cmu.edu/idplus/plaidcash/locations.html.

Student Advantage
A four-year Student Advantage membership can be added to your ID Card. With Student Advantage, you can receive discounts of up to 50% off at more than 20,000 locations nationwide. Learn how to add Student Advantage at www.cmu.edu/idplus/advantage.
University Policies

http://www.cmu.edu/policies

Policy on Cheating and Plagiarism

Students at Carnegie Mellon are engaged in preparation for professional activity of the highest standards. Each profession constrains its members with both ethical responsibilities and disciplinary limits. To assure the validity of the learning experience a university establishes clear standards for student work.

In any presentation, creative, artistic, or research, it is the ethical responsibility of each student to identify the conceptual sources of the work submitted. Failure to do so is dishonest and is the basis for a charge of cheating or plagiarism, which is subject to disciplinary action.

Cheating includes but is not necessarily limited to:

1. Plagiarism, explained below.
2. Submission of work that is not the student’s own for papers, assignments or exams.
3. Submission or use of falsified data.
4. Theft of or unauthorized access to an exam.
5. Use of an alternate, stand-in or proxy during an examination.
6. Use of unauthorized material including textbooks, notes or computer programs in the preparation of an assignment or during an examination.
7. Supplying or communicating in any way unauthorized information to another student for the preparation of an assignment or during an examination.
8. Collaboration in the preparation of an assignment. Unless specifically permitted or required by the instructor, collaboration will usually be viewed by the university as cheating. Each student, therefore, is responsible for understanding the policies of the department offering any course as they refer to the amount of help and collaboration permitted in preparation of assignments.
9. Submission of the same work for credit in two courses without obtaining the permission of the instructors beforehand.

Plagiarism includes, but is not limited to, failure to indicate the source with quotation marks or footnotes where appropriate if any of the following are reproduced in the work submitted by a student:

1. A phrase, written or musical.
2. A graphic element.
3. A proof.
4. Specific language.
5. An idea derived from the work, published or unpublished, of another person.

Computing and Information Resources Code of Ethics

The ethical principles which apply to everyday community life also apply to computing. Every member of Carnegie Mellon has two basic rights: privacy and a fair share of resources. It is unethical for any other person to violate these rights.

Privacy

• On shared computer systems every user is assigned an ID. Nobody else should use an ID without explicit permission from the owner.
• All files belong to somebody. They should be assumed to be private and confidential unless the owner has explicitly made them available to others.
• Messages sent to other users should always identify the sender.
• Network traffic should be considered private.
• Obscenities should not be sent by computer.
• Records relating to the use of computing and information resources are confidential.

Resources

• Nobody should deliberately attempt to degrade or disrupt system performance or to interfere with the work of others.
• Loopholes in computer systems or knowledge of a special password should not be used to alter computer systems, obtain extra resources, or take resources from another person.
• Computing equipment owned by departments or individuals should be used only with the owner’s permission.
• University resources are provided for university purposes. Any use of computing for commercial purposes or personal financial gain must be authorized in advance. Many of the agreements that the university has specifically forbid this activity.
• Computing and information resources are community resources. Theft, mutilation, and abuse of these resources violate the nature and spirit of community and intellectual inquiry.

System Administration

• On rare occasions, computing staff may access others’ files, but only when strictly necessary for the maintenance of a system.
• If a loophole is found in the security of any computer system, it should be reported to the system administrator and not used for personal gain or to disrupt the work of others.
• The distribution of programs and databases is controlled by the laws of copyright, licensing agreements, and trade secret laws. These must be observed.

This code of ethics lays down general guidelines for the use of computing and information resources. Failure to observe the code may lead to disciplinary action. Offenses that involve academic dishonesty will be considered particularly serious.

Policies on Examinations

Preamble

The Faculty Senate adopted the following policies on the administration of examinations for the undergraduate courses (defined as courses that are numbered 6xx or below). These policies represent an understanding between faculty and student concerning an important but often stressful period, especially at the conclusion of each academic semester and at mid-semester. There should be no expectation that the following points will cover every conceivable situation. The student should anticipate the demands of the exam schedule, plan accordingly and early, and be prepared. The faculty should recognize that the student is encumbered with many tightly orchestrated and intensive obligations during this period over which he or she has no control: expectations should be reasonably consistent with the number of course units and, of course, should be made known to the student well in advance of the final examination period, preferably as part of the course syllabus.

In order to help students plan their time and study optimally for examinations, this document lays out in some detail the policies regarding final and in-term examinations. Instructors are requested to provide notification of the major in-term examinations in the course syllabus. The final examination date is posted early in the semester. It is the responsibility of the student to give his or her instructor sufficient notice and to work with the instructor to reschedule examinations if this is needed.

Definitions

• Final examination period. The university’s official final examination period begins on the Monday immediately following the last day of classes and continues through the last day of scheduled final examinations, with the exception of reading day(s).
• Scheduled final examinations. Scheduled final examinations are those scheduled by Enrollment Services.
• Self-scheduled examinations. An instructor may choose not to fix a schedule for the final examination, but instead allow each student to choose the examination time; such exams are called self-scheduled examinations.
• Final examinations. Final examinations can either be comprehensive, covering all course materials, or non-comprehensive, covering only a part of the course.
• In-term examinations. Major examinations during the semester are referred to here as in-term examinations.

I. In-Term Examinations

1. All in-term examinations should be given during the regularly scheduled class time. However, if the exam requires additional time to complete, then examinations may be administered outside of regularly scheduled class time.
II. Final Examinations

1. All scheduled final examinations are held at the end of the semester during the university’s official final examination period. Comprehensive final examinations are not required for each course, but are given at the option of the department or instructor. The reading day and weekend preceding the examination days shall never be used for examination purposes of any kind, unless a student opts to take a self-scheduled examination during this time. Non-comprehensive final examinations or final projects (but not both) are allowed during this final examination period only in courses that do not give a final comprehensive examination.

2. Instructors are expected to return all work assigned no later than the last regular day of classes in courses for which there is a final examination. In cases when this is not possible, an answer key, solution sets or equivalent feedback should be provided unless the final examination will not cover material in work that has not been returned.

3. No other coursework, including laboratory or studio work, will be due during the final examination period unless it is assigned in advance and in lieu of the course’s final examination. Regardless of whether there is a final examination in the course, no classes other than review sessions shall be held during the final examination period. Review sessions should be scheduled for optimal attendance, and a serious effort should be made to accommodate students who cannot attend. In appreciation of the time required to prepare for final examinations, no other examinations, portfolio reviews, critiques or juries shall be scheduled for the last class day of a course with a final examination.

4. Instructors shall never exert or submit to pressures to move an examination so that people can leave earlier nor pressure students to take an examination on a reading day or weekend preceding examinations.

5. No student is required to take more than two scheduled examinations that start within a 25-hour period. A student who has more than two examinations scheduled within a 25-hour period or has two examinations scheduled at the same time should first contact the instructors of the courses for assistance in resolving conflicts. If the problem cannot be resolved by that means, the student should contact the department head of his or her college.

6. Take-home final examinations shall be given for any 24-hour period of the student’s choosing during the final examination period.

7. Students are expected to present themselves at the place assigned at the start of the examination; late arrival will reduce the total time a student has to complete the examination, unless instructor’s course policy indicates otherwise. Instructors reserve the right to require attendance within a specific time period. Students who miss an examination with a reasonable excuse and wish to petition for a make-up final examination should check with the instructor. Instructors are encouraged to include late arrival policy and make-up exam policy in the course syllabus.

8. Any student shall be permitted to review his or her corrected, graded final examination in the presence of an instructor or a teaching assistant. Any controversy arising from this review shall be dealt with in accordance with the university procedure for the appeal of grades and academic actions. A final examination that is not returned to a student will be kept available for a year for review. In the event that the instructor or teaching assistant is not available for the review, the responsibility shall rest with the department head of the instructor offering the course or his or her designee. Instructors are expected to return all work assigned before the final examinations, they are not responsible for retaining unclaimed coursework.

9. Concerns related to final examination, complaints about violations of the final examination policy or alterations of the final examination schedule should be directed to the department head of the instructor offering the course or to the associate dean of the student’s home college.

Contact
Questions concerning this policy or its content should be directed to the Vice Provost for Education, (412) 268-5865.

Exam Conflict Guidelines
The University Education Council has passed a guideline regarding students with exam conflicts as follows:

If a student has been scheduled to have more than the number of exams in a designated time period permitted by university policy, it is the student’s responsibility to take immediate action to reach a timely resolution.

The following guideline has been developed and proposed and approved by University Education Council (UEC), Associate Deans’ Council (ADC), and Associate Deans for Graduate Programs (ADGP) to facilitate this process.

1. The student should begin by informing all of the instructors involved to determine if they can suggest an easy resolution. This should be done at least two weeks prior to the exam.

2. If one of the courses is already offering an alternate time for the exam, the student must agree to that resolution unless another class is in conflict with the proposed time.

3. If a resolution cannot be found, the following hierarchy for compromise is recommended: (Student’s Home Department> Student’s College> Smallest Class Size> Higher Course level)
   - If one of the courses is offered in the student’s home department, that should be the first to accommodate. A class in the home college would be the second.
   - The smallest class size should be the next factor in accommodation decisions.
   - The highest level class should be final factor in accommodation decisions.

At any point in the process, the student’s associate dean may be consulted to assist in the negotiation and resolution and they will also be the point of conflict verification.

Student Health Insurance Policy

Reason for Policy
The high cost of health care in the United States presents a potentially serious health and financial risk to students and their accompanying dependents. The absence of adequate insurance coverage can result in temporary or permanent interruption of a student’s education. The university is committed to offering student health insurance that provides access to quality health care and achieves a balance between premium cost and adequate coverage without overburdening students’ financial resources. This balance is best achieved through a mandatory/hard waiver insurance program that mitigates the effect of adverse selection.

Policy Statement General Requirements
All full-time students are required to carry health insurance and will be assessed a charge for the individual basic mandatory plan offered through the university student health insurance program. The charge will appear on the invoice of the first semester of attendance in the academic cycle. The student is required to take one of the following three actions:

1. Enroll in the basic plan as charged.

2. Upgrade the benefit plan by enrolling in the enhanced student health insurance options during the open enrollment period.

3. Apply for a waiver from the mandatory plan.

Requirements for Waiver
Application for a waiver from the university student health insurance plan must be made to Student Health Services by the last day of the open enrollment period. Students applying for waiver must provide documentation of continuing coverage verifying that they are enrolled as the dependent, partner/spouse or principal in an employer or government-sponsored insurance plan. Additionally, the plan must meet minimum standards for coverage as set forth below:

- It must offer at least 75% coverage for inpatient and outpatient medical services in the Pittsburgh area.
- It must include mental health benefits.
- The deductible must not exceed $500 per accident or illness.
- It must offer medical benefits of at least $50,000 per accident or illness.
- It must cover pre-existing conditions.
Hosts should consider the items below as guidance in planning campus
policies related to space reservation, use, safety and security, keeping in
mind the responsibility to have campus police present for any event with
policies on Freedom of Expression, university hosts must follow all applicable
and thoughtful experiences for those involved. Hosts are responsible for
Carnegie Mellon’s educational mission by planning carefully to create safe
organizations that sponsor invited guests to campus are expected to uphold
embraced. Those who exercise it serve the Carnegie Mellon community
Responsibilities
Freedom of expression must be at once fiercely guarded and genuinely
embraced. Those who exercise it serve the Carnegie Mellon community
by accepting the responsibilities attendant to free expression. University
organizations that sponsor invited guests to campus are expected to uphold
Carnegie Mellon’s educational mission by planning carefully to create safe
and thoughtful experiences for those involved. Hosts are responsible for
the behavior of their guests and should exercise due care to ensure that all
participants abide by relevant university policies.
Considerations for Planning Campus Events
Consistent with the rights and responsibilities outlined in the university’s
policy on Freedom of Expression, university hosts must follow all applicable
policies related to space reservation, use, safety and security, keeping in
mind the responsibility to have campus police present for any event with
100 or more persons in attendance.
Hosts should consider the items below as guidance in planning campus
events, recognizing that not all of the items will apply to all events:
1. A public declaration of the event, its purpose, the identification of
sponsors and co-sponsors, and contact information for those seeking
further information.
2. A plan for advertising the event, including advance notice to relevant
members of the community who may wish to co-sponsor, protest, or
host other events in response to the planned activity.
3. Where appropriate, a clear and detailed contract with outside
speakers, artists, or suppliers of services to ensure continuity of
purpose and the ability of the host to control the event reasonably,
consistent with the host’s intent.
4. A plan for access to the event, including notifying the community of
reserved seats, ticketing, queuing protocol, or other relevant details
or restrictions well in advance of the activity.
5. A provision for security before, during, and after events, managed
in coordination with the University Police. Specifically, non-university
security personnel must have their allowable duties clearly
delineated, in partnership with the University Police, with their role
generally limited to personal security and not to space management.
6. A plan for participant engagement at the event, such as through a
question and answer session, if relevant, with a clear delineation of
the planned ground rules for the event set out well in advance.

7. A strategy for hosting of additional events, discussions, or town
meetings before or after a principal event to help provide a context in
which the principal event may be best experienced.

The Office of Student Activities and the Office of the Dean of Student Affairs
may assist in, or directly coordinate, some aspects of campus events, such as
fostering discussions preceding or following an event, or accommodating
an opposing view at an alternative event. It is assumed that the spirit
of community, both among people with groups with opposing views, as
well as between event sponsors and the Student Activities and Student
Affairs staffs, will foster communication and cooperation in the planning of
campus events. Wherever possible, Student Affairs will work in concert with
University Police to notify occupants of buildings in advance of any potential
disruption caused by such events.

Security Personnel Statement
At times, members of the campus community or their invited guests may
have a legitimate basis for being accompanied by independent security
personnel. It is incumbent upon the host of such an individual to ensure that
University Police approve in advance the presence and scope of involvement
of any such security personnel.

Human Subjects in Research at Carnegie Mellon
The university is committed to the protection of the rights and welfare of
human subjects in research investigations conducted under the jurisdiction
of the university. The university believes that review independent of the
investigator is necessary to safeguard the rights and welfare of human
subjects of research investigations. All research involving human subjects
is conducted in accordance with federal regulations, including Title 45
regulations, human subjects are defined as: living individual(s) about whom
an investigator conducting research obtains:
• data through intervention or interaction with the individual, or
• identifiable private information.

An Institutional Review Board (IRB) is established under the provost to
ensure adequate safeguards. The provost is responsible for the composition
of the IRB with respect to: (1) the qualifications of IRB members in terms of
educational background and research or other relevant experience, and (2)
broader representation of relevant university interests.

This IRB is responsible for reviewing investigational procedures involving
human subjects prior to the initiation of the research procedure in
reference to (1) the rights and welfare of the individuals involved, (2) the
appropriateness of the methods used to obtain informed consent, and (3)
the risks and potential benefits of the investigations. The IRB is responsible
determined when additional expertise is required for adequate review
for and obtaining that additional expertise. The IRB is further responsible for
maintaining records of its review activities and decisions and for ensuring
that records of informed consent are developed and kept by investigators
where appropriate.

It is the responsibility of investigators who plan to use human subjects
in research to obtain written consent from the IRB prior to conducting
an investigation involving human subjects. It is the investigator’s further
responsibility to take whatever steps are determined necessary for
the protection of the subjects, and to meet the reporting requirements
established by the IRB.

Student Immunization Policy
Reason for Policy
Vaccine-preventable diseases continue to occur on American campuses
and pose a significant threat to the public health of the campus community.
Outbreaks not only impose a significant cost to infected individuals in
terms of mortality and morbidity but also can be costly to the university by
disrupting university activities.

Policy Statement
The goal of the Student Health Services and the university is to provide
adequate protection of the campus community against vaccine-preventable
diseases by requiring students to be vaccinated against and/or screened for
certain highly contagious diseases. This goal can best be achieved through
a mandatory prematriculation immunization requirement. The following
requirements are consistent with Pennsylvania State Law and with the
recommendations of the American College Health Association, the Advisory
Committee on Immunization Practices.

Requirements for All Full-Time Students
All entering full-time students born after 1956 must demonstrate proof of
immunity against measles, mumps and rubella by either providing dates
of inoculation of two doses of the measles vaccine and at least one dose of
mumps and rubella or providing blood titers that demonstrate immunity to
these infections or providing documentation from a physician of having had the infection.

Additional Requirements for Students Residing in University Housing

- All students residing in university housing must demonstrate immunity against Hepatitis B by either providing documentation of having initiated or completed the three dose vaccination series.
- The student is expected to complete the series within six months of initiation of the series.
- All students residing in university housing must provide documentation of having been vaccinated against meningococcal meningitis within three years prior to enrollment in the university.
- All full-time international students must provide documentation of having had a PPD skin test to screen for tuberculosis within one year prior to enrollment in the university regardless of prior BCG inoculation. If the results of the skin test are positive, a chest x-ray is required.

Request for Waiver

- A student may request a waiver from any vaccination for medical reasons or if vaccination conflicts with personal or religious beliefs. Application for waiver is to be made in writing to Student Health Services prior to the first day of classes in his/her first semester of attendance at the university. In the case of an outbreak of a contagious disease on campus for which the student has not been immunized, the university reserves the right to ask the student to leave campus until the outbreak is over.
- A student may request a waiver from tuberculin skin testing if the student is from a country that has been identified by the Centers for Disease Control as having low prevalence of tuberculosis.

Penalty for Noncompliance

- If the student fails to comply with the immunization policy, the Student Health Services will notify Enrollment Services who will place a hold on the student’s registration until the requirements are met and assess a fee of no more than $50 to the student’s account.
- Additionally, if the student is a resident in university housing and fails to comply with the immunization requirements, he/she will be removed from housing.

Contact

Questions should be directed to Student Health Services, (412) 268-2157.

Related Policies and Procedures

The university complies with OSHA regulations regarding occupational exposure to blood-borne pathogens. Questions regarding these regulations should be directed to Environmental Health & Safety, (412) 268-8182.

Additional recommendations

A PPD skin test for tuberculosis is recommended for domestic students who have traveled to an area where tuberculosis is endemic. All students should have a booster dose of tetanus/diphtheria every ten years after completion of the primary series.

Intellectual Property Policy

1. Purpose

The policy reflects the following goals:

- To create a university environment that encourages the generation of new knowledge by faculty, staff, and students
- To facilitate wide transfer of useful inventions and writings to society
- To motivate the development and dissemination of intellectual property by providing appropriate financial rewards to creators and the university, and administrative assistance to creators
- To ensure that the financial return from the development of intellectual property does not distort decisions and operations of the university in a manner contrary to the mission of the university.

The policy is based upon the following principles relating the university to society:

- The mission of the university remains the generation and dissemination of knowledge
- Intellectual property will be generated within the university, and there exists an obligation to disseminate it. An interface is needed if better technology transfer is to be achieved, and the university will provide mechanisms for that function

The policy is based upon the following principles relating faculty, staff and students to the university:

- Intellectual property is created by individuals, or by groups of individuals, who are entitled to choose the course of disclosure. Academic freedom of individuals is a higher priority than possible financial rewards
- There exists a historical tradition allowing authors to retain ownership of intellectual property rights from textbooks and works of art
- The university is the support of the whole campus community, and is thereby entitled to share in financial rewards
- There should be incentives for all parties to pursue financial rewards together, consistent with the expressed goals of the policy. The distribution of these rewards should reflect, insofar as possible, the creative contributions of the creator, and the resources contributed by and risks assumed by both the creator and the university in developing intellectual property
- Since it is frequently difficult to assess risks meaningfully, resources and potential rewards, negotiated agreements are to be encouraged whenever possible

2. Definitions

Certain terms are used in this document with specific meanings, as defined in this section. These definitions do not necessarily conform to customary usage.

Intellectual Property includes any patentable invention, any copy-rightable subject matter, or trade secret. It also includes works of art, and inventions or creations that might normally be developed on a proprietary basis.

University means Carnegie Mellon.

Student means any full-time or part-time graduate or undergraduate student, regardless of whether the student receives financial aid from the university or from outside sources. It is the responsibility of students who are also employees of other outside entities to resolve any conflicts between this policy and provisions of agreements with their employers prior to beginning any undertaking at the university that will involve the development of intellectual property.

Faculty means members of the university’s Faculty Organization as defined in the Faculty Handbook, plus instructors and special faculty appointments (even in the first year), and part-time faculty.

Staff means any employee of the university other than students and faculty as defined above. If a student is also a part-time university employee, he is considered as staff with regard to intellectual property developed as a result of his employment, and as a student with regard to other intellectual property. A full-time non-faculty employee who is also taking one or more courses is considered to be staff. Visitors to the university who make substantial use of university resources are considered as staff with respect to any intellectual property arising from such use. (The distinction between faculty and staff does not affect intellectual property rights except for representation on the Intellectual Property Adjudication Committee [see Section 5].)

Creator means any person or persons who create an item of intellectual property.

Net proceeds to the university means all proceeds received by the university on intellectual property that it assigns, sells or licenses, minus any application, litigation, interference, or marketing costs directly attributable to the intellectual property being licensed. Deducted costs shall be reasonable and fair, and shall be properly disclosed; the sources and amounts of compensation shall also be properly disclosed.

Net proceeds to the creator means all proceeds received by the creator from intellectual property owned by him that he sells, assigns or licenses, less the costs of application, legal protection, or litigation, interference, travel and other marketing costs directly attributable to the intellectual property being exploited. Such net proceeds do not include compensation legitimately received by the creator for consulting services or interest or other return on invested labor or capital. Deducted costs shall be reasonable and fair, and shall be properly disclosed; the sources and amounts of compensation shall also be properly disclosed.

Substantial use of university facilities means extensive unreimbursed use of major university laboratory, studio or computational facilities, or human resources. The use of these facilities must be important to the creation of the intellectual property; merely incidental use of a facility does not constitute substantial use, nor does extensive use of a facility commonly
available to all faculty or professional staff (such as libraries and offices), nor does extensive use of a specialized facility for routine tasks. Use will be considered “extensive” and facilities will be considered “major” if similar use of similar facilities would cost the creator more than $5000 (five thousand dollars) in constant 1984 dollars if purchased or leased in the public market. Creators wishing to designate the university for the use of its facilities must make arrangements to do so before the level of facilities usage for a particular intellectual property becomes substantial. (This provision is not intended to override any other department or university policy concerning reimbursement for facilities usage.)

In general:

In any given year the equivalent figure for a particular amount of money in constant 1984 dollars will be obtained by multiplying that amount of money by the ratio of the most recent quarterly Disposable Personal Income Deflator divided by the average monthly Disposable Personal Income Deflator for the year 1984.

As used in this policy, the masculine gender includes the feminine gender, singular or plural, wherever appropriate.


This section states the policies concerning ownership of intellectual property created at the university. In order of precedence, ownership of intellectual property shall be as follows:

3-1. Externally Sponsored Work

Ownership Provisions: Intellectual property created as a result of work conducted under an agreement between an external sponsor and the university that specifies the ownership of such intellectual property shall be owned as specified in said agreement. The university may declare itself to be a sponsor, but does not declare itself to be the owner of the intellectual property, ownership shall be determined in accordance with 3-6-4 below.

Procedural Provisions: It is the responsibility of the Office of Sponsored Research of the university to inform each person whose intellectual property rights are limited by an externally sponsored contract of the intellectual property provisions of that contract in advance of the beginning of work thereon. Such notice is to be in writing and the university may require written acknowledgment of such provisions by any person working on externally sponsored projects. A summary of external sponsorship agreements limiting the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general university community.

If the university fails to notify a creator, effectively and in advance, of limitations imposed on his intellectual property rights by external sponsorship agreements, the creator is entitled to receive from the university 50% (fifty percent) of the net proceeds to the university resulting from his intellectual property.

3-2. Internally Sponsored Work

Ownership Provisions: When the university provides funds or facilities for a particular project to the extent of substantial use, it may also choose to designate itself as sponsor of that work. The university may declare itself to be a sponsor, but does not declare itself to be the owner of the intellectual property, ownership shall be determined in accordance with 3-6-4 below.

Procedural Provisions: It is the responsibility of the Office of Sponsored Research of the university to inform each person whose intellectual property rights are limited by an internally sponsored project of the intellectual property provisions of that contract in advance of the beginning of work thereon. Such notice is to be in writing and the university may require written acknowledgment of such provisions by any person working on internally sponsored projects. A summary of work for which university sponsorship limits the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general university community.

If the university fails to notify a creator, effectively and in advance, of limitations imposed on his intellectual property rights by internal university sponsorship, the creator is entitled to receive from the university 50% (fifty percent) of the net proceeds to the university resulting from his intellectual property.

3-3. Individual Agreements

Ownership Provisions: Intellectual property which is the subject of a specific agreement between the university and the creator(s) thereof shall be owned as provided in said agreement. Such agreements by the university and the faculty are encouraged.

Procedural Provisions: Except where limited by external sponsorship agreements, creators and the university may negotiate individual agreements to govern ownership of intellectual property regardless of the applicability of any other provision hereof.

3-4. Intellectual Property Created Within Scope of Employment

Ownership Provisions: Intellectual property created by university employees who are employed to produce a particular intellectual property shall be owned by the university if said intellectual property was created within the normal scope of their employment. Faculty are presumed not to be hired to produce a particular intellectual property. On the other hand, computer programs written on the job by staff computer programmers would fall under this provision.

3-5. Public Dedication

Ownership Provisions: Except when limited by sub-parts 3-1, 3-2, 3-3 or 3-4 above, a creator of any intellectual property may choose to make his or her creation in the public domain. In such cases both the creator and the university waive all ownership rights to said property.

Procedural Provisions: Creators wishing to place their intellectual property in the public domain are responsible for ascertaining that the right to public dedication of that intellectual property is not limited by any external agreements to govern ownership of intellectual property regardless of the applicability of any other provision hereof. The university provost will provide such a determination in writing upon request by the creator. It is also the creator's responsibility to ensure that disclosure does not include valuable intellectual property owned by others. (This provision does not require the university from its general obligation to notify creators of limitations to intellectual property rights specified in Provisions 3-1 and 3-2.)

To facilitate the actual transfer of knowledge of the intellectual property to the public at large, the creator shall provide the university with a complete description and documentation of the property placed in the public domain, specifically including a copy of the property in the case of printed material, and complete machine-readable source code in the case of software. All such material provided to the university will be placed in the University Library and made available to the public at large. The university will take appropriate action on a regular basis to publicize summary descriptions of intellectual property recently placed in the public domain. The university will also provide any member of the general public copies of such material on a cost-recovery basis.

The provisions of this section do not apply to the normal scholarly or creative publication processes unless the creator intends to waive all proprietary rights to the publication.

3-6. In General

Unless governed by sub-parts 3-1, 3-2, 3-3, 3-4 or 3-5 above, owner-ship of intellectual property created at the university shall be determined as follows:

3-6-1. Traditional Rights Retained

Ownership Provisions: In keeping with academic traditions at the university, the creator retains all rights to the following types of intellectual property, without limitation: books (including textbooks), educational course-ware, articles, non-fiction, novels, poems, musical works, dramatic works including any accompanying music, pantomimes and choreographic works, pictorial, graphic and sculptural works, motion pictures and other similar audio-visual works, and sound recordings, regardless of the level of use of university facilities. This provision does not include computer software (other than educational course-ware) or data bases.

Procedural Provisions: The types of intellectual property listed in the preceding paragraphs are subject to the following limitations. Because of their utilitarian nature, ownership rights with respect thereto are governed by 3-6-3 or 3-6-4. Educational course-ware is included in this provision in all cases because of its role in furthering the primary educational mission of the university.

This provision applies regardless of any university sponsorship of the work, and it may be modified by a specific prior agreement between the creator and the university. The use of university-owned computers and other facilities in the preparation of books and similar works does not alter this provision, though other university policies may limit such use or require reimbursement to the university. Similarly, the use of externally sponsored resources does not alter this provision, unless the creator is effectively notified in advance of such limitations to his rights in accordance with 3-1.

3-6-2. No Substantial Use of University

Facilities Ownership Provisions: The creator owns all intellectual property created without substantial use of university facilities, including intellectual property rights in computer software and data bases.
3-6-3. Substantial Use of University Facilities - No External or Internal Sponsorship
Ownership of intellectual property created with substantial use of university facilities, but not directly arising from externally sponsored work, or from work for which the university has declared itself as sponsor, shall be determined as set forth hereinafter depending on whether the creator or the university develops said property.

3-6-3-1. Development by Creator
Ownership Provisions: The creator originally owns intellectual property created with substantial use of university facilities but no external or internal sponsorship, and retains said ownership by commercial development of said property subject to the following:

(i) the university shall receive 15% (fifteen percent) of the net proceeds to the creator above $25,000 (twenty-five thousand dollars) in constant 1984 dollars from all sources (in the case of patents and copyrights, this provision shall be limited to the life of the patent or copyright); and

(ii) the university shall receive a perpetual, non-exclusive, non-transferable, royalty free license to use said intellectual property. In the case of software, the creator above $25,000 (twenty-five thousand dollars) in constant 1984 dollars from all sources (in the case of patents and copyrights, this provision shall be limited to the life of the patent or copyright); and

3-6-3-2. Development by the University
Ownership Provisions: When intellectual property is created with substantial use of university facilities, but not directly arising from sponsored research, the creator will originally retain the rights to the property, provided that he desires to commercially develop the property himself or to make it available to the public. If, however, the creator elects not to commercially develop same or fails to show diligence in pursuing such development, then the university may request that the creator decide to the university a fraction of his net proceeds, but not from the provision of this paragraph for a non-exclusive license to the university.

Procedural Provisions: If the creator develops an intellectual property that is covered by this provision, he must make full and fair disclosure to the university of all such sources of compensation relating to that intellectual property.

3-6-4. Substantial Use of University Facilities - External or Internal Sponsorship
Ownership of intellectual property created with substantial use of university facilities and directly arising from work sponsored under an agreement between an external sponsor and the university, or from work for which the university has declared itself a sponsor, but for which neither the external sponsor nor the university have specified the ownership of resulting intellectual property shall be determined as set forth hereinafter depending on whether the creator or the university develops said property.

3-6-4-1. Development by University
Ownership Provisions: The university originally owns intellectual property acquired by the university through an external or internal university sponsorship agreement and retains said ownership by commercial development of said property, subject to the following: in all cases, the creator shall receive 50% (fifty percent) of the net proceeds to the university.

Procedural Provisions: When an intellectual property is created with substantial use of university resources provided by an external or internal university sponsorship agreement, and that contract or agreement either does not specify the disposition of the intellectual property rights arising from that sponsorship, or it permits the university and/or creator to retain or acquire such intellectual property rights, the university will originally retain the rights to such intellectual property.

3-6-4-2. Development by Creator
Ownership Provisions: When intellectual property is created with substantial use of university facilities provided by external or internal sponsorship, the university will originally retain the rights to the property, provided that it desires to commercially develop the property or to make it available to the public. If, however, the university elects not to commercially develop same or fails to show diligence in such development, the ownership rights to that property may be acquired by the creator. Intellectual property acquired by the creator in this fashion will be treated as in 3-6-3-1 above.

This assignment of rights to the creator may be prohibited by the terms of an external university sponsorship agreement with the university or by an internal university sponsorship declaration, but in such cases the creator must be notified in advance, as in Provisions 3-1 and 3-2.

Procedural Provisions: At the time the intellectual property is disclosed to the university’s provost as required by Section 4-1, or at any time thereafter, the creator may request that the university decide whether it will commercially develop the intellectual property or execute an assignment of the intellectual property rights to the creator. Such a decision must be made within 120 (one hundred twenty) days of the request or the university automatically waives its rights in favor of the creator, and it must execute an assignment of these rights to the creator.

3-6-5. Consulting Agreements
Ownership Provisions: Work done by individuals as consultants to outside firms is presumed not to involve the use of university facilities, and the rights to intellectual property created under consulting agreements are retained by the outside firms or the individual as specified by the terms of the consulting agreement and the terms of Provision 3-6-2 above.

Procedural Provisions: Under university policy consulting work must not involve substantial unreserved use of university facilities except by explicit prior agreement. Any member of the university community who is engaged in consulting work or business is responsible for ensuring that provisions in his agreements are not in conflict with this policy of the university or with the university’s commitments. The university’s Innovation Transfer Office will, upon request, provide assistance in this respect. The university’s rights and the individual’s obligations to the university are in no way abrogated or limited by the terms of such agreements. Each creator of intellectual property should make his obligations to the university clear to those with whom he makes such agreements and should ensure that they are provided with a current statement of the university’s intellectual property policy. Appropriate sample contract wording to cover various possible external consulting arrangements shall be available from the university provost.

4. General Procedures

4-1. The creator of any intellectual property that is or might be owned by the university under this policy is required to make reasonably prompt written disclosure of the work to the university’s provost, and to execute any document deemed necessary to perfect legal rights in the university and enable the university to file patent applications and applications for copyright registration when appropriate. This disclosure to the provost should be made at the time when legal protection for the creation is contemplated, and it must be made before the intellectual property is sold, used for profit, or disclosed to the public. Whenever legal protection for intellectual property is anticipated all persons engaged in such creative activity are encouraged to keep regular notebooks and records.

4-2. Whenever the university undertakes commercial development it shall do so, if possible, in a fashion that provides for the widest possible dissemination, avoiding suppression of inventions from which the public might otherwise benefit, providing for non-exclusive licensing at reasonable royalties, and giving consideration to more favorable or royalty-free licensing to non-profit charitable institutions, minority businesses or enterprises in developing countries.

4-3. The university’s share of any proceeds under this policy will be used to reimburse the university for its expenses for commercial development of intellectual property. Any additional return to the university will be used to further the academic purposes of all the disciplines of the entire university.

5. Resolution of Disputes
This policy constitutes an understanding which is binding on the university and on the faculty, staff, and students upon whom it is effective according to the terms of Section 6 below, as a condition for participating in research programs at the university or for the use of university funds or facilities.

Any question of interpretation or claim arising out of or relating to this policy, or dispute as to ownership rights of intellectual property under this policy, will be settled by the following procedure:

Carnegie Mellon University
• The issue must first be submitted to the university’s Intellectual Property Adjudication Committee in the form of a letter setting forth the grievance or issue to be resolved. The committee will review the matter and then advise the parties of its decision within 60 days of submission of the letter.

• If any of the parties to the dispute is not satisfied with the committee’s decision, the party may seek binding arbitration in Pittsburgh, Pennsylvania in accordance with the Rules of the American Arbitration Association then in effect. Judgment upon the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof. The arbitrator(s) will give some weight to the decision of the Intellectual Property Adjudication Committee in reaching a decision. The losing party of the arbitration hearing will pay for all costs of the arbitration unless the arbitrator(s) specifies otherwise.

The Intellectual Property Adjudication Committee will consist of a chair who is a member of the tenured faculty, four other members of the faculty, and four other members representing, respectively, the university administration, the technical staff, and the graduate and undergraduate student bodies. Initially, half of the members of the committee (including the chair) will be appointed for two-year terms of office, and the remaining half will be appointed for a one-year term. After one year new members of the committee will be appointed for two-year terms of office. The chair will be appointed by the chair of the Faculty Senate, with the advice and consent of the Faculty Senate Executive Committee, and the remaining eight members of the committee will be appointed by the president of the university or his designee. At all times at least one of the faculty members will have had significant practical experience with intellectual property development and exploitation. The faculty members appointed by the president of the university will be selected from a list of nominees prepared by the Faculty Senate or its designated committee and nominees with experience in intellectual property development will be identified as such by the Faculty Senate. The staff representative will be selected from a list of nominees prepared by Staff Council, and the administration representative will be named directly by the president of the university or his designee. The graduate student representative will be selected from a list of nominees prepared by the Graduate Student Organization. The undergraduate representative will be chosen from a list of nominees prepared by the Student Senate. The committee will use the guidelines set forth in this policy to decide upon a fair resolution of any dispute. If possible, the committee will also provide on request informal advisory opinions to creators and the university indicating how it is likely to interpret the provisions of this policy as it applies to special cases.

6. Effective Date of Policy
This policy will become effective August 27, 1985. Once effective this policy will be binding on new faculty, administration, and staff when hired, on existing faculty and staff when hired, on current faculty and staff and students may choose to become bound by this policy for future and pending intellectual property by voluntary written consent. Intellectual property that is already developed or under development at the time that an amendment to the policy is ratified will not be bound by the terms of the amendment without the voluntary written consent of both the creator and the university.

Footnote:
1. This document presumes the existence of a university office to facilitate technology transfer. Such an office would serve as a clearinghouse for contacts with outside partners, would perform patent and copyright tasks, and would develop an effective marketing capability.

Policy on Student Privacy Rights

Policy Statement
Under the Family Educational Rights and Privacy Act (FERPA), you have the right to:
• Inspect and review your education records;
• Request an amendment to your education records if you believe they are inaccurate or misleading;
• Request a hearing if your request for an amendment is not resolved to your satisfaction;
• Consent to disclosure of personally identifiable information from your education records, except to the extent that FERPA authorizes disclosure without your consent;
• File a complaint with the U.S. Department of Education Family Policy Compliance Office if you believe your rights under FERPA have been violated.

1. Inspection
What are education records?
Education records are records maintained by the university that are directly related to students. These include biographical and demographic data, application materials, course schedules, grades and work-study records. The term does not include:
• Information contained in the private files of instructors and administrators, used only as a personal memory aid and not accessible or revealed to any other person except a temporary substitute for the maker of the record;
• Campus Police records;
• Employment records other than work-study records;
• Medical and psychological records used solely for treatment purposes;
• Records that only contain information about individuals after they have left the university;
• Any other records that do not meet the above definition of education records.

How do I inspect my education records?
• Complete an Education Inspection and Review Request Form (available online as a PDF document or from The HUB, 12C Warner Hall) and return it to The HUB.
• The custodian of the education record you wish to inspect will contact you to arrange a mutually convenient time for inspection, not more than 45 days after your request. The custodian or designee will be present during your inspection.
• You will not be permitted to review financial information, including your parents’ financial information; or confidential letters of recommendation, if you have waived your right to inspect such letters.
• You can get copies of your education records from the office where they are kept for 25 cents per page, prepaid.

2. Amendment
How do I amend my educational records?
• Send a written, signed request for amendment to the Vice President for Enrollment, Carnegie Mellon University, 610 Warner Hall, Pittsburgh, PA 15213. Your request should specify the record you want to have amended and the reason for amendment.
3. Hearing
How do I request a hearing?

- Send a written, signed request for a hearing to the Vice President of Campus Affairs, Carnegie Mellon University, 610 Warner Hall, Pittsburgh, PA 15213. The university will schedule a hearing no later than 45 days after your request.
- A university officer appointed by the Vice President of Campus Affairs, who is not affiliated with your enrolled college will conduct the hearing.
- You may bring others, including an attorney, to the hearing to assist or represent you. If your attorney will be present, you must notify the university ten days in advance of the hearing so that the university can arrange to have an attorney present too, if desired.
- The university will inform you of its decision, in writing, including a summary of the evidence presented and the reasons for its decision, no later than 45 days after the hearing.
- If the university decides not to amend the record, you have a right to add a statement to the record that explains your side of the story.

4. Disclosure
Carnegie Mellon generally will not disclose personally identifiable information from your education records without your consent except for directory information and other exceptions specified by law.

What is directory information?
Directory information is personally identifiable information of a general nature that may be disclosed without your consent, unless you specifically request the university not to do so. It is used for purposes like compiling campus directories.

If you do not want your directory information to be disclosed, you must notify The HUB, 12C Warner Hall, in writing within the first 15 days of the semester.

Notifying The HUB covers only the disclosure of centralized records. Members of individual organizations such as fraternities, sororities, athletics, etc. must also notify those organizations to restrict the disclosure of directory information.

Carnegie Mellon has defined directory information as the following:

- your full name,
- local/campus address and local/campus telephone number,
- email user id and address,

User ids cannot be completely suppressed from our electronic systems. While it may be possible to suppress the association of an individual’s name with their user id, doing so may adversely impact the delivery of electronic mail or other electronic services.

- major, department, college,
- class status (freshman, sophomore, junior, senior, undergraduate or graduate)
- dates of attendance (semester begin and end dates),
- enrollment status (full, half, or part time)
- date(s) of graduation,
- degree(s) awarded,
- sorority or fraternity affiliation.

For students participating in intercollegiate athletics, directory information also includes:

- height, weight
- sport of participation.

What are the other exceptions?
Under FERPA, Carnegie Mellon may release personally identifiable information from your education records without your prior consent to:

- school officials with legitimate educational interests ("School officials" are Carnegie Mellon employees in administrative, supervisory, academic or support staff positions; Carnegie Mellon trustees; individuals and companies with whom the university has contracted, such as attorneys, auditors, or collection agencies; and individuals assisting school officials in performing their tasks. School officials have a “legitimate educational interest” if they need to review an education record in order to fulfill their professional responsibilities.);
- certain federal officials in connection with federal program requirements;
- organizations involved in awarding financial aid;
- state and local officials who are legally entitled to the information;
- testing agencies such as the Educational Testing Service, for the purpose of developing, validating, researching and administering tests;
- accrediting agencies, in connection with their accrediting functions;
- parents of dependent students (as defined in section 152 of the Internal Revenue Service Code);
- comply with a judicial order or subpoena (after making a reasonable effort to notify the student in advance of compliance so that the student can take protective action, except in cases where the university is legally required not to disclose the existence of the subpoena);
- appropriate parties in a health or safety emergency, if necessary to protect the health or safety of the student or other individuals;
- officials of another school in which the student seeks or intends to enroll;
- victims of violent crimes or non-forcible sexual offenses (the results of final student disciplinary proceedings);
- parents or legal guardians of students under 21 years of age (information regarding violations of university drug and alcohol policies);
- courts (records relevant to legal actions initiated by students, parents or the university).

5. Complaints
If you believe the university has not complied with FERPA, you can file a complaint with the:

Family Policy Compliance Office, Department of Education, 400 Maryland Avenue, S.W. Washington, DC 20202-4605

Policy on Restricted Research
Universities have two primary purposes: to create knowledge and to disseminate knowledge. Carnegie Mellon University recognizes the importance of open intellectual communication within a research group, within the university, and within the larger community outside. Ideally, all units of the university would disseminate the results of research as quickly and as widely as possible. Some members or units of the university, however, desire to do research that may be difficult or impossible without restrictions or without access to classified or proprietary materials.

There exists, therefore, a tension between the university’s goal of disseminating knowledge freely and the desire on the part of some of its members to conduct restricted research on important problems. The university intends to guarantee the academic freedom of all faculty members to do research in their own manner on topics of their own choosing, provided that such research is consistent with the overall purposes of the university.

This policy seeks to resolve the tension between the desire to participate in restricted research and the desire to maintain the open atmosphere of the university by confining restricted research to semi-autonomous units, which are not associated with any academic departments. It thereby establishes the principle that restricted research is inappropriate at Carnegie Mellon University except in the semi-autonomous units.

This policy does not attempt to anticipate all possible concerns about restricted research. In some cases, decisions will need to be made about particular research projects to which the application of particular policy guidelines are not clear. In choosing to accept or decline such projects, the university will weigh the potential of a project for generating and disseminating new knowledge for the benefit of society, against the project’s potential for adversely affecting the climate for research conducted in a free and open environment. While this policy sets no explicit limits on the extent of classified research permitted in the semi-autonomous units, it is not the intent of the policy to encourage any unit of the university to engage in classified research as a primary ongoing activity. Indeed, it is expected that classified projects will never represent more than a small fraction of the total research effort in any unit.

Definitions
Research: all projects and investigations involving the creation of new knowledge of a theoretical or practical nature. The term “research” as used here encompasses both “research” and “development” as they are commonly defined.
Classified research: research, the free dissemination of the results of which is deemed to jeopardize national security. The federal government controls access to the environment in which such research is performed, restricts discussions about the work in progress to individuals with clearance and a "need to know," and limits publication of research, results or access to data needed to verify results, for a specified period of time.

Proprietary research: research that results in intellectual property that is owned by entities other than Carnegie Mellon University. Such entities may wish to market products derived from inventions or ideas that are developed at the university. They might, therefore, desire to fund projects which restrict access to data and to discussions about work in progress to individuals with a "need to know," and to seek, for a specified period of time, a delay in publication of research results or data needed to verify results. Such entities may also provide access to proprietary material, which researchers must agree not to include in publications.

Publication: oral or written dissemination.

Restricted research: includes all classified research, and any proprietary or other research that requires more than a six month delay in publication of the research results.

Semi-autonomous units: units of the university specifically so designated by the president, after consultation with the URC and the Faculty Senate, currently the Mellon Institute and the Software Engineering Institute.

Non-autonomous units: all university entities other than semi-autonomous units.

Restricted Research in Non-Autonomous Units
It is the policy of Carnegie Mellon that restricted research is inappropriate and, therefore, not permitted within its non-autonomous units.

It is also the policy of Carnegie Mellon not to permit involvement of students in projects which carry restrictions that may impede their progress toward a degree. Therefore, students should not be involved in contracts that require the delay of a student's publication of research results when such results are intended for use in obtaining academic credit, except that a sponsor may require a delay of thirty days for review of publications for removal of proprietary information that was provided by the sponsor for the conduct of the research.

Proprietary research is allowed within non-autonomous units provided it is subject to limitations (excluding students' publications as noted above) no more stringent than the following:

- A sponsor may request a delay of up to six months in publication so that steps may be taken to secure intellectual property rights to inventions or ideas developed under the contract.
- A sponsor may require a delay of thirty days for review of publications for removal of proprietary information which was provided for the conduct of the research.

Considerations for faculty/researchers:
The university recognizes that problems arise in both restricted research and research that is not itself restricted but that involves access to classified or propriety information or materials (hereinafter, restricted materials). Researchers may also have access to restricted materials when serving as consultants. Access to restricted materials gives rise to concerns about limitations on researchers' freedom to communicate. In such instances, researchers must exercise consider-able judgment to conduct their research in an open environment while protecting the restricted materials to which they have access. Researchers must also be aware that the university will judge their performance as researchers through their publications or through other scholarly products that arise from their research. Research that is restricted in dissemination, or not available for public review, cannot be considered in promotion or reappointment decisions or in evaluations of academic performance of any kind.

Considerations for faculty/researchers:
There are important concerns about the involvement of students in restricted research. It is necessary for students to publish their work in order to obtain degrees, course credit and professional recognition. Students rely to a large degree on their faculty advisor's judgment for guidance and advice. Research that is restricted in dissemination, or not available for public review, cannot be used for academic credit. Thus, before working on such research, a student must be notified in writing that work on this research may not be used for academic credit.

Restricted Research in Semi-Autonomous Units
The semi-autonomous units associated with Carnegie Mellon may conduct restricted research.

Faculty members may conduct restricted research in or in cooperation with semi-autonomous units only on a consulting basis or by means of a formal, internal leave of absence from their non-autonomous units.

Work that is restricted in any way may not be used for academic evaluations until it is released for publication, and then only with respect to future academic actions.

Students may occasionally be employed by the semi-autonomous units, provided that such employment does not interfere substantially with progress toward a degree. However, they must be made aware that work that is restricted cannot be used for academic credit. Work that was restricted and is later released for dissemination and review can be applied toward future academic credit. Students should be discouraged from working on restricted research in which dissemination may be delayed indefinitely.

Guidelines for all Units
Work by students on restricted research projects shall not be made a condition for admission or financial aid.

The principal investigator is responsible for informing all members of a project (faculty, staff and students) of any restrictions imposed on the dissemination of information related to the research. This must be done prior to the start of the project or prior to an individual joining an existing project.

Restrictions on access to university facilities due to the conduct of restricted research must be kept to a minimum. Access to and movement through the facilities in which restricted research is conducted must be consistent with standard university procedures.

The Provost's Office is responsible for obtaining signed documents from principal investigators on restricted research projects attesting that they are aware of all restrictions imposed on the research and that they have informed all participants of these restrictions.

The Office of Sponsored Research shall review all proposals and contracts prior to approval for conformity with these guidelines. Any that do not meet these guidelines will be referred to the University Research Council (URC) for review and recommendation of appropriate action to the provost.

To maintain a balance with the university's goals of broad dissemination of knowledge, the URC will conduct an annual review of all restricted research being conducted at the university. This review will be made based on a listing of all contracts that involve restricted research. This listing shall include the title and sponsor(s) of the research, name(s) of principal investigator(s), and the amount of funding of each contract.

The university community will be informed annually, through the URC's written report to the Faculty Senate and Student Senate, of the nature and overall impact of restricted research at Carnegie Mellon.

Existing sponsored research projects shall be allowed to continue under the terms of their present contract. However, renewal contracts must conform with this policy.

Student Activities Fee
By action of the Board of Trustees, a required Student Activities Fee in addition to tuition is charged to all under-graduate students and graduate students who enroll for 19 units or more. Student Government is responsible for administering the fee and for using it only for the support of projects under the following guidelines:

1. Activities and facilities which can be described as meeting the reasonably predictable social, cultural, recreational, or welfare needs of college students.
2. Publications which can reasonably be presumed to serve the needs of the student community for communication, expressions of opinion, and the conduct of their business.
3. Such enterprises of an entrepreneurial nature undertaken by the student body as can reasonably be expected to serve as an instrument for meeting the needs described above.

All functions and services provided by the fees described above must be in accordance with Carnegie Mellon's policy on non-discrimination. In addition, no use of such fees may be intended to violate or circumvent the policies of the university or the laws of the land.

Final responsibility for establishing the amount of any required fee rests with the Board of Trustees, which will consider changes only upon requests of the Student Government and the officers of the university.

Note: Historically, the Student Government has dedicated a specific portion of graduate students' activities fees to the Graduate Student Assembly to be used at their discretion.
Policy on Temporary Emergency Closing of the University

Policy Statement

Carnegie Mellon University has an important commitment to students, parents, sponsors, benefactors and the community. Accordingly, the university will make every attempt to operate normally during severe weather or other emergencies. This includes holding classes, conducting research programs, and operating facilities and services. The university will attempt to operate normally unless such operation represents a clear danger to students, staff or faculty.

There may be occasions when the university community is served best by suspending normal operations. In that event, only the president (or the president's designated representative) has the authority to close the university and to specify those persons or group of persons who are free to leave or refrain from coming to campus. Staff members who provide primary services, including certain members of Physical Plant, Dining Services and Security, may be asked to work.

Standard Operations

Unless the president announces that the university is closed, everyone is expected to be at work as usual. When the university is in session, faculty members are expected to meet their scheduled classes and other obligations. If a faculty member is unable to meet a scheduled class, he or she should notify the department office and arrange either for a qualified substitute or for a future make-up session.

If the university is open but a staff member is unable to come to work because of severe weather or other emergency, he or she should notify the supervisor as soon as possible. Staff members will be expected to make up lost time or use Paid Time Off (PTO), consistent with regular operating protocols.

Announcement of Closing

As soon as the president or his/her designee determines that the university must be closed, University Relations will alert local radio and television stations. Also, announcements of closings will be posted on the Carnegie Mellon electronic bulletin board (cmu-news).

Contact

Questions concerning this policy or its intent should be directed to the Office of the President, (412) 268-2200.

Student Leave Policy

www.cmu.edu/policies/documents/StLeave.html

Students must sometimes interrupt their studies for a variety of reasons (financial, academic or personal). Students choosing to take a leave of absence should first contact their department advisor to discuss their plans while on leave and to work out any conditions that may be necessary for a smooth return to Carnegie Mellon.

A student may leave Carnegie Mellon by either withdrawing from the university (leaving the university temporarily, with the firm and stated intention of returning) or by taking a leave of absence (leaving the university temporarily, with no intention of returning) or by taking a leave of absence (leaving the university with no intention of returning). Students choosing to take a leave of absence should first contact their department advisor to discuss their plans while on leave and to work out any conditions that may be necessary for a smooth return to Carnegie Mellon.

A Leave of Absence Form must be completed by all students requesting a leave. A Withdrawal Form must be filled out by all students who are withdrawing. Notifying instructors and no longer attending classes does not complete the process. Forms are available in the academic departments, deans' offices and on The HUB website. Not completing the form results in the recording of student courses and grades for taking a leave in a semester follows the deadlines for semester or mini courses, as follows:

- All courses or grades are removed, on or before the university deadline to drop classes with W (withdrawal) grades.
- W (withdrawal) grades will be assigned to all classes (for undergraduate students, and to graduate students only in Tepper School of Business or the Mellon College of Science.), after the university deadline to drop classes but before the last day of classes:
- Permanent grades assigned by the instructor will be recorded, after the last day of classes.

Contact

Questions concerning this policy or its intent should be directed to: The HUB, (412) 268-8186.

Student Return Policy

http://www.cmu.edu/policies/documents/StReturns.html

Policy Statement

Students on leave wishing to return to Carnegie Mellon to resume their degree studies may do so under several conditions. In order to be considered for return from leave, a student must first obtain a Return from a Leave of Absence form from The HUB or their academic department. This application requires information from the student regarding the intended semester of return, current address information and information about their leave. This application must be submitted to their home department at least one month prior to the beginning of the semester.

Undergraduates may return within their same academic department within two years. After two years, students returning in the same academic department are subject to space constraints and academic performance review. Graduate students must negotiate their return with their home department and must follow their department policy.

The Return from Leave of Absence form requires approval of the student's academic department and Dean. If a student's department chooses to deny the student's Return from Leave of Absence form, the student may appeal to their Dean. Any constraints governing the student's eligibility to return will be specified directly on the application by the academic department and/or Dean's office or the Office of Student Affairs.

Students who have taken courses elsewhere must submit an official transcript and course descriptions with their Return from Leave of Absence form. Transfer credit approval is determined by the academic department based on course level, performance and appropriateness to the student's curriculum requirements. Credit transfer is subject to college-specific policy. Failure to submit the necessary documents at the time of return will result in denial of transfer credit.

The process of returning is not completed until all necessary signatures on the Return form are obtained by the student and until all outstanding bills are paid. Enrollment Services will then notify the appropriate university offices of the student's return.

Contact

Questions concerning this policy or its intent should be directed to: The HUB, (412) 268-8186.

Tuition Adjustment Policy

www.cmu.edu/policies/documents/TuitionRefund.html

Application

This policy applies to withdrawals and leaves of absence by all students (graduate, undergraduate, non-degree) for all semesters (Fall, Spring, Summer 1, Summer 2, Summer All).

Official Date of Withdrawal/Leave of Absence

For students who notify the university of their intent to withdraw or take a leave of absence, the official date of withdrawal or leave of absence is the earliest of:

- the date the student began the withdrawal or leave of absence process;
- the date the student notified his or her home department;
- the date the student notified the associate dean of his or her college;
- the date the student notified the dean of students.

For students who do not notify the university of their intent to withdraw or take a leave of absence, the official date of withdrawal or leave of absence is:

- the last day of classes for the student.
• the midpoint of the semester;
• the last date the student attended an academically-related activity such as an exam, tutorial or study group, or the last day a student turned in a class assignment.

Tuition Adjustment

Students who withdraw or take a leave of absence before completing 60% of the semester will be charged tuition based on the number of days completed within the semester. This includes calendar days, class and non-class days, from the first day of classes to the last day of final exams. Breaks which last five days or longer, including the preceding and subsequent weekends, are not counted. Thanksgiving and Spring Break are not counted. There is no tuition adjustment after 60% of the semester is completed. No tuition is charged to a student who is administratively withdrawn. See The HUB website for the complete tuition assessment schedule for the current semester.

Housing, Dining Plan & Fee Adjustments

Housing charges are adjusted daily, beginning on check-in day and ending on the last day of final exams for the semester. Holiday breaks are included. The Winter Break period is not included.

Dining plan charges are adjusted per the bi-weekly period. DineXtra and PaidCash are assessed based upon actual use.

There is no adjustment of the Port Authority Fee, the Technology Fee or Student Activity fee.

Financial Aid Adjustment

Federal and institutional financial aid is adjusted on the same basis as tuition. A student earns 100% of his or her federal or institutional financial aid when 60% of the semester is completed.

State grants and non-federal outside scholarships are adjusted based upon the withdrawal policy of the agency awarding the funds.

Financial Aid Adjustment

Federal and institutional financial aid is adjusted on the same basis as tuition. A student earns 100% of his or her federal or institutional financial aid when 60% of the semester is completed.

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Student Accounts Receivable Collection Policy and Procedures

Policy Statement

A student is responsible for the payment of charges incurred at the university by the stated payment deadline. The purpose of this policy statement is to detail the specific process and action steps to be used to resolve any outstanding student account balance.

Procedural Overview

Enrollment Services will take progressive action to resolve any student account balance greater than $500. These actions include: communication, first with the student and second with the parent/s, regarding the account status, academic and administrative consequences of nonpayment, and the provision of information and realistic payment options to resolve the delinquent balance; communication with appropriate university service administrators and the associate dean of the student’s college concerning the same issues communicated to the student and parent/s.

In situations where the university attempts to resolve the outstanding balance but the student has not made or met satisfactory arrangements for payment, the university will take one or both of the following two actions: (1) financial suspension and/or (2) wage garnishment.

In the case of financial suspension, the student will be restricted from registering for and enrolling in university courses and programs, and s/he will be excluded from using university academic and administrative services. Enrollment Services will also notify the appropriate university service administrators and the associate dean of the student’s college.

In situations where the university attempts to resolve the outstanding balance but the student has not made or met satisfactory arrangements for payment, the university will take one or both of the following two actions: (1) financial suspension and/or (2) wage garnishment.

In the case of financial suspension, the student will be restricted from registering for and enrolling in university courses and programs, and s/he will be excluded from using university academic and administrative services. Enrollment Services will also notify the appropriate university service administrators and the associate dean of the student’s college.

If a student is employed by Carnegie Mellon, the university may garnish the student’s wages to recover the amount due to the university. Enrollment Services will notify the student prior to any action, and the amount garnished will be tailored to individual circumstances.

Prior to the registration period for the upcoming semester, Enrollment Services will send correspondence to any student who has a carry-over balance and who has not developed or maintained a satisfactory repayment plan. This correspondence will advise the student and parent/s that the student will be ineligible to register for the upcoming semester until s/he pays the balance in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and the associate dean of the student’s college.

Additionally, the student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, career center services, degree verification and the release of (official) academic transcripts for the upcoming semester.

If the student has an overdue balance at the completion of the current term (a carry-over balance greater than or equal to $500 for any term), Enrollment Services will send a letter to the student and parent/s to advise them that the student has been “financially suspended” and that s/he will not be permitted to return to the university until the account balance is paid in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and to the associate dean of the student’s college.

If at any point in the process the student’s account balance is paid in full, Enrollment Services will update the student’s enrollment status and release the hold on his/her academic and financial records. The student will then be able to register for courses and use university academic and administrative services. Enrollment Services will also notify the appropriate university academic and administrative staff members.

Currently Enrolled Students/New Balance Due

Enrollment Services will notify, in writing, any enrolled student who has an account balance greater than $500 for 20 days beyond the stated payment due date. The letter will state that s/he risks administrative action by the university, including possible financial suspension, if the student does not resolve the outstanding balance.

Graduating student with any balance due

During the spring semester, Enrollment Services will notify, in writing, any graduating student with an account balance. The letter will state that s/he risks administrative action by the university, including possible financial suspension, if the student does not resolve the outstanding balance.

Financial Aid Adjustment

The student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, career center services, degree verification and the release of (official) academic transcripts.

Currently Enrolled Students/Carry-over Balance Due

A student who received account balance action letters from Enrollment Services during the previous semester, and who has an account balance greater than $500 following the current semester deadline for enrollment, will be subject to the following procedures.

Enrollment Services will send notification of continued nonpayment after the 15th day of classes (third week) to the student and parent/s, the university service administrators and the associate dean of the student’s college. This action will be documented in the student’s administrative records.

Enrollment Services will work with the student and parent/s to resolve the financial issue. Payment arrangements will follow standard practices related to collections, to include a promissory note with a specified repayment schedule within the current semester. Requests for exceptions to standard collection practices, such as extending the payment schedule beyond the current semester, must be made in writing to the vice president for enrollment. All requests will be reviewed by the Student Accounts Receivable Committee, composed of the vice president for enrollment, vice president for business, the dean of student affairs and the directors of Enrollment Services. Input from the associate dean of the student’s college will be requested and considered. When a payment agreement is reached, Enrollment Services will mail a letter to the student and parent/s detailing the conditions of the agreement and the risk of financial suspension if the agreement is not fulfilled. This correspondence will be copied to representatives of the Student Accounts Receivable Committee and to the associate dean of the student’s college.

If a financial agreement is not reached, the student will be financially suspended. The student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of (official) academic transcripts for the upcoming semester.

If the student is an employee of the university, the university may garnish the student’s wages to recover the amount due to the university. Enrollment Services will notify the student prior to any action, and the amount garnished will be tailored to individual circumstances.

Prior to the registration period for the upcoming semester, Enrollment Services will send correspondence to any student who has a carry-over balance and who has not developed or maintained a satisfactory repayment plan. This correspondence will advise the student and parent/s that the student will be ineligible to register for the upcoming semester until s/he pays the balance in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and the associate dean of the student’s college.

Additionally, the student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, career center services, degree verification and the release of (official) academic transcripts for the upcoming semester.

If the student has an overdue balance at the completion of the current term (a carry-over balance greater than or equal to $500 for any term), Enrollment Services will send a letter to the student and parent/s to advise them that the student has been “financially suspended” and that s/he will not be permitted to return to the university until the account balance is paid in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and to the associate dean of the student’s college.

If at any point in the process the student’s account balance is paid in full, Enrollment Services will update the student’s enrollment status and release the hold on his/her academic and financial records. The student will then be able to register for courses and use university academic and administrative services. Enrollment Services will also notify the appropriate university academic and administrative staff members.

Delinquent Account/Financially Suspended

A student who has been financially suspended and who retains an account balance will be subject to the following procedures.
Enrollment Services will send a series of financial status letters to the student indicating the consequences of nonpayment or continued account delinquency. Enrollment Services will mail the first letter when the student is classified as having a delinquent balance, with follow-up letters at distinct intervals from the point in time Enrollment Services determines that the student’s account is in a delinquent status. Enrollment Services will also use telephone conferences with the student and parent/s.

Enrollment Services will note any response to the financial status letter or telephone communication with the student and parent/s in the student’s financial records, along with any arrangements for payment. Enrollment Services will update the student’s account balance to reflect any payment and will assign an appropriate follow-up review date to ensure that the student continues to take action to resolve the financial delinquency.

If at any point in time Enrollment Services determines that internal collection efforts have been unsuccessful, Enrollment Services will refer the student’s account to an outside collection agency. Enrollment Services will notify the student and parent/s before any referral to a collection agency.

If the student’s account balance is paid in full at any point in the process, Enrollment Services will update the student’s account status and release the hold on his/her academic and financial records. The student will be able to register for courses and use university academic and administrative services. Enrollment Services will notify the appropriate university academic and administrative staff members.

Contact

Questions concerning this policy or its intent should be directed to: The HUB, (412) 268-8186.

Financial Aid Policy Statement

University Academic Scholarship Renewals

Carnegie Mellon University awards academic scholarships as part of the freshman financial aid process. Each of these scholarships is renewable for four academic years of study (five for architecture) based upon the maintenance of a specific cumulative quality point average. The academic scholarship renewal criteria are included in the scholarship notification letter which is mailed to the student prior to the May 1 matriculation deadline.

Each scholarship recipient’s cumulative quality point average is reviewed at the end of each academic year. If the student achieves the scholarship renewal criteria, then the scholarship is automatically renewed for the next academic year.

If the student does not meet the cumulative quality point average requirement for renewal, then he/she is given the opportunity to appeal. A merit scholarship appeal form and instructions are automatically sent to the student at the end of each academic year.

The student’s completed appeal form is reviewed by members of the Enrollment Services staff. Input from the Associate Dean of the student’s college is also considered. The student is notified, in writing, of the decision. The decision may be to renew the scholarship for the entire academic year, renew the scholarship for one academic term, or to reject the appeal. If the appeal is rejected, a written explanation is provided to the student.

Undergraduate Tuition Exchange Programs

Carnegie Mellon University assesses the standard tuition charge for the undergraduate tuition exchange programs.

Since Carnegie Mellon assesses the tuition charge, the student can be considered for all forms of institutional, state, and federal aid for which the student may be eligible with the exception of any student employment program.

Undergraduate Study Abroad Programs

Carnegie Mellon University does not assess the tuition charge for any of the Study Abroad Programs.

Since Carnegie Mellon does not assess the tuition charge, the student is not considered for any institutional grants and scholarships. However, Carnegie Mellon will consider any student participating in an approved Study Abroad Program for all state and federal student aid programs for which the student may be eligible with the exception of any student employment program.

The U.S. Department of Education and Carnegie Mellon University define an approved Study Abroad Program as one which is part of a contractual agreement between Carnegie Mellon and the host institution. Additionally, courses taken in the Study Abroad Program must be accepted for transfer to Carnegie Mellon by the Dean of the student’s college.

Undergraduate Sponsored Study Abroad Programs

Carnegie Mellon assesses full tuition charges and all applicable fees to students participating in an undergraduate sponsored study abroad program.

Undergraduate International Students

Documentation Eligibility (U.S. Citizenship or Eligible Noncitizen)

You must be a U.S. Citizen or permanent resident alien to receive federal student aid. If you are a U.S. Citizen, but were not born in the United States, valid documentation includes a copy of your passport or naturalization certificate.

If you are a U.S. permanent resident alien or refugee, acceptable forms of verification include a photocopy of both sides of your I-551 or I-551C card.

Undergraduate international students are ineligible to receive any federal or state student financial aid. Additionally, Carnegie Mellon does not award any institutional financial aid funds to undergraduate international students.

Undergraduate Course Meeting Policy

No undergraduate classes, exams, academic, or artistic activities (including: extra help session, rehearsals, ROTC drill, make-up exams, etc.) are scheduled on weekdays between 4:30 p.m. and 6:30 p.m. Extra class time beyond those regularly scheduled must take place either before 4:30 p.m. or after 6:30 p.m.

Undergraduate Course Meeting Procedure

This policy is not intended to reduce the vigor of the academic or artistic activities, but to ensure that students have a period in which they are free to carry on co-curricular activities and athletics. Scheduling classes, exams, or other academic and artistic activities makes it very difficult for the students to meet these commitments. Since we are all concerned about the quality of life at the university, this time must be held for the students.

In planning the academic course schedule, Enrollment Services will review all courses to ensure that no academic or artistic courses be scheduled in this period. In addition, any requests to schedule additional or makeup course meetings, review and/or study sessions, teaching assistant office hours, or other course-related meetings, must take place either before 4:30 p.m. or after 6:30 p.m. This includes meetings in all university spaces, not just within Enrollment Services controlled classrooms.

As with any policy, there must be a means of making exceptions. Any academic or artistic activities which you feel must be scheduled between 4:30 p.m. and 6:30 p.m. must be cleared with the Vice President for Enrollment. These requests must be in writing either as a memo or through e-mail (http://coursecatalog.web.cmu.edu/servicesandoptions/ universitypolicies/mailto:web16@andrew.cmu.edu). All requests must include the course relationship, intent for the requested meeting, and the reason why the meeting cannot be held either before 4:30 p.m. or after 6:30 p.m.

Any further clarification of this policy can be addressed to the Vice President for Campus Affairs.

Statement of Assurance

Carnegie Mellon University does not discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex, handicap or disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Furthermore, Carnegie Mellon University does not discriminate and is required not to discriminate in violation of federal, state, or local laws or executive orders.

Inquiries concerning the application of and compliance with this statement should be directed to the vice president for campus affairs, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-2056.

Courses and Registration

Availability of Required Courses
In order to ensure that students do not have to compete for access to their required courses, registration priority is given to students who are registering for courses in their primary major. Although the University encourages the exploration of other disciplines, access to courses outside a student’s primary major (including those courses that fulfill requirements for an additional major, minor, etc.) is on a space-available basis and is not guaranteed.

Change in Schedule (Add/Drop)
Scheduling changes must be made within the period in the semester as established in the Official University Calendar. A student cannot drop a course by simply notifying the instructor(s) or by ceasing to attend class(es). A student dropping all of his/her courses (with the intent of leaving the university) must file an Application for Withdrawal or an Application for Leave of Absence (see the “Student Leave Policy” for more information).

Undergraduate students at Carnegie Mellon may drop a course by following the instructions for dropping a course in Student Information Online (SIO) on or before the appropriate deadline as published in the Official University Calendar. This applies to all courses with the exception of half-semester mini courses. When a course is dropped by these deadlines, the course is removed and does not appear on the academic record.

After the Add/Drop deadlines or to drop below 36 units, students must see their Academic Advisor to facilitate schedule changes.

The Late Add Form is used for adding a course or switching sections after the established add period and during the semester in which the course is offered. Students can check Student Information On-line to see if the appropriate schedule changes have been made. Undergraduate students who add a course or switch a section after the established add period are required to obtain the permission of their home Dean’s Office or the Head of their School. If adding a course would result in a schedule overload, the permission of the student’s advisor is also required. Graduate students must have the permission of their department.

If adding a course would result in a schedule overload, the signature of the student’s advisor is also required if requested by Associate Dean/Department Head.

Graduate students must have the permission of their department.

International students who wish to drop below full-time must consult the Office of International Education.

The deadline to add a mini course is the end of the first week of classes for that course. The deadline to drop a mini course is one week after the midpoint for that course.

Free Electives
A free elective is any Carnegie Mellon Course. However, a maximum of nine units of physical education, military science (ROTC), and/or student-taught (StuCo), courses may be used toward fulfilling graduation requirements.

Overloads
The University is committed to insuring that each degree candidate has access to a normal course load before it permits other students to register for a greater than normal number of units. A normal course load has been established by each academic department. Students should check with their academic advisor, department head, or dean’s office for the definition of a normal course load. Individual colleges may have overload policies that are more restrictive, therefore students should consult with their advisor when considering an overload. Students may register for an overload up to 12 units with the approval of their academic advisor if they have demonstrated their ability to successfully complete a normal course load. Successful completion of a normal course load is defined as having earned at least a 3.00 (3.50 for students in ECE) cumulative GPA through the preceding semester or at least a 3.00 (3.50 for students in ECE) semester GPA in the current semester (in which case all final grades must be recorded before the student can register for the overloaded class). Overloads greater than 12 units or other exceptions must have the approval of the student’s Associate Dean. Freshmen and transfer students are limited to a normal course load in their first semester of attendance.

Conduct of Classes
Students are expected to attend all scheduled classes unless the instructor explicitly informs the class that other ways of doing the work are acceptable. The action to be taken in regard to tardiness, absence from class or making up late work is the responsibility of the individual instructor; the instructor should consult with the department head and the student’s dean if major action, such as dropping the student from the course, is being considered.

All classes will be held at their scheduled hour on days immediately before and after all holidays and recesses. Both faculty and students are expected to be present.

Members of athletic teams and other student organizations are permitted to be absent from classes to participate in authorized contests and presentations, either at home or out of town, provided the following conditions are met:

• All work missed must be made up to the satisfaction of the instructor(s) concerned;
• No trip shall involve an absence of more than two days, excluding days when classes are not scheduled;
• The total number of days of absence shall not exceed six per sport or per organization annually;
• Each student will obtain an absence authorization signed by the director or sponsor of the organization involved and by the Dean of Student Affairs. The student will present this authorization to the instructor. This is not an excuse for work missed.

Technology afforded many students access to portable devices including cell phones, PDAs, and laptops. It is expected that students will respect the wishes of faculty with regard to the use of electronic devices within the academic environment.

Students who, because of religious beliefs, cannot attend class may arrange as individuals to be absent, provided the work missed is made up in a manner satisfactory to the instructor(s) of the class(es) missed.

No student shall leave a scheduled exercise because of the absence of the instructor until a reasonable time has passed. By tradition and as a matter of courtesy a student should wait 10 minutes before leaving.

Course Attendance and Enrollment
A student is responsible for the payment of charges incurred at the university by the stated payment deadline. The purpose of this policy statement is to detail the specific process and action steps to be used to resolve any outstanding student account balance.

Students will be held financially and academically accountable for course(s) which they attend or for which they are enrolled. Enrollment in a course which is not actively taken, or contrarily, the taking of a course for which enrollment has not been completed, will result in the assignment of a grade and responsibility for applicable tuition charges.

Students who fail to resolve their enrollment and balances will be prohibited from using university academic and administrative services. The services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of academic transcripts for the upcoming semester.

Undergraduate Course Meetings
Usually, no undergraduate classes, exams, academic, or artistic activities (including extra help sessions, rehearsals, ROTC drill, make-up exams, etc.) are scheduled on weekdays between 4:30 p.m. and 6:30 p.m. On occasion, some courses may be scheduled during these hours by Enrollment Services when they are also offered at other times: students may elect to take such courses during the 4:30 to 6:30 p.m. period.
Grades

Grading Policies

Policy Statement

This policy offers details concerning university grading policies for students taking courses, whether those students are undergraduates, non-degree students or graduate students. This policy covers the specifics of Assigning and Changing Grades (including Final and Mid-Semester grades, In-completes and Conditional Failures), Grading Options (Audit and Pass/Fail), Drop/Withdrawals, Course Repeats, and defines the undergraduate and graduate Grade Standards.

Questions about grading for a specific course should be addressed to the instructor of the course in question. Graduate students with questions about Pass/Fail and Drop/Withdrawal should contact their individual programs.

Appeals for an exception to any grading policy may be made by the dean’s office of the student’s home college.

1. Definitions

Certified terms are used in this document with specific meanings, as defined in this section.

Student means any full-time or part-time degree-seeking undergraduate or graduate student, or full-time or part-time non-degree student.

Non-degree student means a student who is not in a university degree program.

Faculty means members of the university’s Faculty Organization as defined in the Faculty Handbook, plus instructors and special faculty appointments (even in the first year), and part-time faculty.

Instructor means a faculty member, teaching assistant, and /or lecturer who is the instructor of record, as recorded in the Student Information System (SIS).


Assigning Grades

Final grades are awarded to each student, in each course scheduled, at the end of the semester, mini-semester or summer session. All students taking a course at Carnegie Mellon must be assigned grades.

Enrollment Services will query instructors who do not assign a grade to a student. Copies of the query regarding the lack of grade will be sent to the student, to the dean and to the department head. If the instructor does not assign a grade, the course will be administratively assigned. The instructor’s name will be noted in the student’s academic record.

Assigning Grades

Changing a Grade

A student who believes that an assigned grade is incorrect, may request that a final grade be changed. Final grades will be changed only in

Exceptional cases and only with the approval of the instructor and, in the case of undergraduate students, with the approval of the dean’s office of the college/ school offering the course; for graduate students, department approval is required. The intention of this policy is to insure that, under normal circumstances, all students in a class are treated equally and no student is unduly advantaged.

Mid-Semester Grades

Mid-semester grades provide valuable feedback to students as they assess their performance in courses. Furthermore, mid-semester grades and the QPA’s they generate are used by Deans and advisors in identifying and dealing in a timely way with students in academic trouble. Therefore it is imperative that mid-semester grades accurately reflect student performance and are turned in on time.

Mid-semester grades are not permanent and are kept only until final grades are recorded. Because mid-semester grades are not permanent, changes of mid-semester grades as a rule will not be accepted.

Incomplete Grades

Carnegie Mellon students are expected to complete a course during the academic semester in which the course was taken. However, if the instructor agrees, a grade of I (incomplete) may be given when a student, for reasons beyond his or her control, has been unable to complete the work of a course, but the work completed to date is of passing quality and the grade of incomplete provides no undue advantage to that student over other students.

In awarding an I grade, an instructor must specify the requirements for completing the work and designate a default letter grade where no further work is submitted. Students must complete the required course work no later than the end of the following academic semester, or sooner if required by prior agreement. The instructor must record the permanent grade by the last day of the examination period of that following semester, or Enrollment Services will administratively assign the default grade.

Conditional Failures

X grades are conditional failures. They are factored in the student grade point average as a failure in the semester they are awarded and can be replaced by nothing higher than a D. When awarding an X grade, the instructor specifies to the student the requirements necessary to achieve a grade of D. Requirements may be the completion of a prescribed course with a performance of C or better or may be specified work related to the course in which the student received the X. Students must complete the required course work no later than the end of the following academic semester, or sooner if required by prior agreement.

The instructor must record the permanent grade of D by the last day of the examination period of that following semester, or Enrollment Services will administratively assign the default grade of R.

Pass/Fail Grades

Undergraduate students may elect to take a free-elective course pass/fail unless precluded by the course, the course’s department or the student’s home department/college. Policies for graduate students vary and students should be advised to check with their individual colleges/departments/programs for details.

A student must submit a Pass/Fail Form to Enrollment Services indicating the course and the grade (pass/fail) they are electing as pass/fail before the end of the university’s drop period. This decision is irreversible thereafter. No information regarding the student’s decision will be passed on to the instructor. Instructors will submit letter grades, which will automatically be converted to pass/fail.

A through D work will receive credit for units passed and be recorded as P on the student’s academic record, below D work will receive no credit and will be recorded as W on the student’s academic record. No quality points will be assigned to P or N units; P or N units will not be factored into the student’s QPA.

In exceptional circumstances, departments may ask to designate a course pass/fail or request that the course be evaluated only with letter grades. The College Council must approve designating a course as pass/fail only or as graded only if such a decision will have an adverse effect on the requirements of any other college. Academic Council must review the decision. The decision to designate a course as graded or pass/fail must be made before the add period for the course and is irreversible thereafter.

Audit Grades

Auditing is presence in the classroom without receiving academic credit, a pass/fail or a letter grade. The extent of a student’s participation must be agreed and approved by the course instructor. A student wishing to audit a course is required to register for the course, complete the College Audit Approval Form, obtain permission of the course instructor and their advisor, and return the form to the College of Business prior to the last day to add a course.

Any student enrolled full-time (36 units) may audit a course without additional charges. Part-time or non-degree students who choose to audit a course will be assessed tuition at the regular per-unit tuition rate.

Drop/Withdrawal Grades

Students at Carnegie Mellon may drop a course by accessing on-line registration on or before the drop deadline as published in the official university calendar. This applies to all courses with the exception of mini-semester courses. Policies for graduate students vary and students should be advised to check with their individual colleges/departments/programs for details. The deadline to drop a mini-semester course is the last day of the fourth week of the mini-semester course. When a course is dropped by these deadlines, the course is removed and does not appear on the academic record.

After the deadline to drop, students may withdraw from a course by accessing on-line registration on or before the drop deadline as published in the official academic transcript and will be calculated in the student’s QPA.

This is the case regardless if the first grade for the course is a passing or failing grade, including Pass/Fail.
Undergraduate students who wish to repeat a course already passed must obtain approval from the student’s Dean or Department Head. When a student takes a course s/he has already passed, only one set of units will count towards graduation requirements.

3. University Grading Standards

The undergraduate student Grading Standard is as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality Points</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
<td>Good</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>D</td>
<td>1.0</td>
<td>Passing</td>
</tr>
<tr>
<td>R</td>
<td>0.0</td>
<td>Failure</td>
</tr>
<tr>
<td>X</td>
<td>0.0</td>
<td>Conditional Failure</td>
</tr>
<tr>
<td>P</td>
<td>Non-Factorable</td>
<td>Passing</td>
</tr>
<tr>
<td>N</td>
<td>Non-Factorable</td>
<td>Not Passing</td>
</tr>
<tr>
<td>O</td>
<td>Non-Factorable</td>
<td>Audit</td>
</tr>
<tr>
<td>W</td>
<td>Non-Factorable</td>
<td>Withdrawal</td>
</tr>
<tr>
<td>I</td>
<td>Non-Factorable</td>
<td>Incomplete</td>
</tr>
<tr>
<td>AD</td>
<td>Non-Factorable</td>
<td>Credit granted for work completed at another institution or examination credit</td>
</tr>
</tbody>
</table>

This grading standard is for all students classified as seeking an undergraduate degree and special students taking undergraduate courses. Any +/- grades received by undergraduate students when taking graduate-level courses will automatically convert to the corresponding letter grade as listed in the scale above.

The graduate student Grading Standard is as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality Points</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.33</td>
<td>(Not applicable to CIT or Dietrich College)</td>
</tr>
<tr>
<td>A+</td>
<td>4.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>A-</td>
<td>3.67</td>
<td></td>
</tr>
<tr>
<td>B+</td>
<td>3.33</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>B-</td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td>C+</td>
<td>2.33</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>C-</td>
<td>1.67</td>
<td></td>
</tr>
<tr>
<td>D+</td>
<td>1.33</td>
<td>(Not applicable to Tepper School, Heinz College, or Dietrich College)</td>
</tr>
<tr>
<td>D</td>
<td>1.00</td>
<td>(Not applicable to Tepper School, Heinz College, or Dietrich College)</td>
</tr>
<tr>
<td>R</td>
<td>0.0</td>
<td>Failure</td>
</tr>
<tr>
<td>X</td>
<td>0.0</td>
<td>Conditional Failure</td>
</tr>
<tr>
<td>S</td>
<td>Non-Factorable</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>P</td>
<td>Non-Factorable</td>
<td>Passing</td>
</tr>
<tr>
<td>N</td>
<td>Non-Factorable</td>
<td>Not Passing</td>
</tr>
<tr>
<td>O</td>
<td>Non-Factorable</td>
<td>Audit</td>
</tr>
<tr>
<td>W</td>
<td>Non-Factorable</td>
<td>Withdrawal</td>
</tr>
<tr>
<td>I</td>
<td>Non-Factorable</td>
<td>Incomplete</td>
</tr>
<tr>
<td>AD</td>
<td>Non-Factorable</td>
<td>Credit granted for work completed at another institution or examination credit</td>
</tr>
</tbody>
</table>

Grading standards are based upon a student’s home academic program and are defined by their home college. The college’s standards determine if certain grades are applicable and if undergraduate course are factored into their mid-semester and final semester quality point averages (QPA). Otherwise, the university policy is that only graduate courses (700 level and higher, unless a department specifies 600 level as graduate) are factored into the semester QPA.

Pass/Fail policies for graduate students vary and students should be advised to check with their individual college/department/program for details.

Minimum passing grades in graduate courses are determined by the department and college policy. Any course that a graduate student completes will be graded using this scale.* This includes undergraduate courses taken by graduate students, and non-degree students taking graduate courses.

Contact

Questions concerning this policy or its intent should be directed to Enrollment Services, 8-8186.

Units and Quality Points

Carnegie Mellon has adopted the method of stating in “units” the quantity of work required of students. In each subject of study, the college catalog tells how much time per week is expected of the average student for each kind of work (e.g., recitations, laboratory, studio, study). For the average student, one unit represents one work-hour of time per week throughout the semester. The number of units in each subject is fixed by the faculty of the college offering the subject. Three units are the equivalent of one traditional semester credit hour.

A subject requiring 9 hours of the average student’s time per week for a semester is known as a 9-unit subject. For example, Chemistry might require 3 hours in the laboratory, 3 hours of lecture/recitation and 3 hours of preparation, a total of 9 work hours. Mathematics might require 3 hours of recitation plus 3 hours of preparation for each recitation, a total of 12 work hours.

Final grades are given “Quality Point Values” as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Meaning</th>
<th>Quality Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>Good</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>(satisfactory)</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Passing</td>
<td>1</td>
</tr>
<tr>
<td>R</td>
<td>Failure</td>
<td>0</td>
</tr>
</tbody>
</table>

Units earned for a course multiplied by the Quality Point Value of the grade given for that course equals the Quality Points for that course. For example, a 9-unit course assigned a “C” grade is awarded 18 quality points (9 units x 2 quality points = 18 quality points). Total Quality Points divided by Total Units Factorable equals the Quality Point Average.

For example, a student’s record in one semester might be:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Units</th>
<th>Quality Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>44</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>D</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>R</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Units = 48
Total Quality Points = 98

Quality Point Average (98 divided by 48) = 2.04

“I” (incomplete), “P” (pass), and “W” (withdrawal) grades are not awarded quality points and are not considered as “factorable” units when calculating the QPA.

The same procedure is applied to all grades earned at the university to establish the Cumulative Quality Point Average.

Dean’s List

Undergraduate students who meet specific academic requirements are added to their home college’s Dean’s List each semester. This is noted on the student’s transcript for applicable semesters. Each college may have its own requirements for Dean’s List qualification; these are described in the individual college sections of the Catalog.

Note: Only undergraduate degree-seeking students may earn a place on the Dean’s List. Non-degree and exchange program students are not eligible.

Transfer Credit Evaluation and Assignment Policy

The Policy on Grades for Transfer Courses, originally dated January 13, 1993, and approved by the Committee on Educational Programs and Student and Faculty Affairs states:
“Carnegie Mellon University offers students the opportunity to take courses for credit through a cross-registration program and through the receipt of transfer credit from other accredited institutions. The Carnegie Mellon University transcript will include information on such courses as follows:

Carnegie Mellon courses and courses taken through the university’s cross-registration program will have grades recorded on the transcript and be factored into the QPA. All other courses will be recorded on this transcript indicating where the course was taken, but without grade. Such courses will not be taken into account for academic actions, honors or QPA calculations. (Note: Coursework taken when a student is on suspension is not acceptable for transfer credit.)

Definitions

A Carnegie Mellon course is one conducted under Carnegie Mellon University regulations regarding course content and grading and taught by faculty under the supervision of a Carnegie Mellon academic unit. Courses taught by Carnegie Mellon faculty on the Carnegie Mellon campus qualify. Courses that are part of the regular offerings of other universities do not qualify, unless faculty at the other universities receive appointments at Carnegie Mellon and handle Carnegie Mellon students under Carnegie Mellon academic regulations.

Courses offered for cross-registration are those taken under the PCHE (Pittsburgh Council on Higher Education) agreement during the regular academic year.

Only official and final college or university transcripts will be accepted for the awarding of transfer credit. Grade reports, letters and the like are not acceptable. It is the responsibility of the Offices of Enrollment Services and Admission to verify official transcripts. Official transcripts for the awarding of transfer credit will reside in the student’s permanent university academic folder in the Office of Enrollment Services.

It is the responsibility of each academic department to review and establish transfer course credit for their degree-seeking students.

Transfer Credit Evaluation Procedure

External Transfer Students

External applicants applying for transfer to Carnegie Mellon will arrange for submission of:

- official transcripts to the Office of Undergraduate Admission as part of the admission process.
- official, final transcripts to the Office of Undergraduate Admission once they are admitted and prior to their beginning coursework at Carnegie Mellon.

As part of the admission process, Admission will verify the official final transcripts, and then send them to the appropriate academic unit responsible for college/department acceptance decisions. Each unit will be responsible for student’s review of transfer credit and the establishment of transfer course credit for each individual student.

Current Students

Current Carnegie Mellon students taking courses at other accredited institutions (colleges and universities), during either summer semesters or as part of exchange programs or other departmentally approved programs, or while on leave from Carnegie Mellon, must arrange for courses taught by Carnegie Mellon faculty on the Carnegie Mellon campus to be recorded on the student’s Carnegie Mellon University transcript.

Upon receipt, Enrollment Services will verify these official transcripts and send a copy of the transcript to the appropriate academic unit responsible for that student’s college/department transfer credit decisions. The official transcript will reside in the student’s university academic folder in Enrollment Services. Each unit will be responsible for its students’ transfer credit review and the establishment of transfer course credit for each individual student. Should a unit receive the official transcript, it must be sent immediately to Enrollment Services.

Standard Course Equivalents for Advanced Placement/International Baccalaureate Units Policy

The university has standard units assigned to Advanced Placement (AP) and International Baccalaureate (IB) credits for all majors. Standard course equivalencies for each exam will be determined by “expert departments” in each college for each acceptable AP/IB score.

Under this procedure, students’ AP or IB credit for a particular course will only go toward their degree requirements if allowed by the home department or college policies. Should a student decide to transfer to another major and/or academic unit within the university, AP/IB credits applicability to new degree requirements will depend upon the requirements of the new home department (or college). Students may only be granted credit for the Higher Level IB exams. This policy assumes no significant AP and/or IB exam changes. In the event of significant exam changes, students will be notified of any resulting policy changes no later than July 30 prior to their enrollment to take effect the fall of that year.

Rank in Class

Undergraduates at Carnegie Mellon pursue degrees in one or more of our ten schools or colleges. They may choose to pursue coursework, majors and minors within and between schools/colleges. In an institution where students’ educational experiences are so varied, class rank is not a meaningful way to measure achievement.

Carnegie Mellon and Enrollment Services does not report nor record students’ rank in class, rank in college and rank in department. For those graduate school and/or employment requests that request a students’ rank, they will be completed with the statement “Carnegie Mellon does not report rank in class.”

Official Transcripts and Verifications

Transcripts

The student’s official transcript is to be considered the official record for all degree(s), major(s), minor(s), and honors. The official Carnegie Mellon transcript includes both the undergraduate and graduate record. All transcripts come in individually sealed envelopes, unless otherwise specified. Transcript requests are not processed if the student has an outstanding obligation, financial or otherwise. We cannot accept phone or e-mail requests. We will not fax a transcript under any circumstances.

Visit The HUB website, www.cmu.edu/hub, for complete information, including information on ordering official transcripts.

Verifications

Enrollment verifications are available only for currently enrolled Carnegie Mellon students and Carnegie Mellon Alumni.

An enrollment verification officially confirms information about you. Please note that we cannot fax your QPA or verifications that contain anything besides the following:

- Name
- Local address
- Local phone number
- E-mail address
- Class
- College
- Department
- Dates of attendance
- Date(s) of graduation
- Degree(s) awarded

The most common reasons for requesting a verification are:

- Student loan agencies and insurance companies wanting to know if a student is enrolled.
- Scholarship committees wanting to know if a student maintained a certain GPA.
- Potential employers wanting to know if a student graduated with a certain degree.

On-Line Verification Ordering

Currently enrolled Carnegie Mellon students may order enrollment verifications via Student Information On-Line (https://sis.as.cmu.edu/sio).

For additional information, visit The HUB website (http://www.cmu.edu/hub).

Full-Time Status

Undergraduates who are registered as full-time students as of the 10th day of classes are expected to remain full-time for the duration of the semester. Full-time is defined by a minimum of 36 units. Permission to drop below the 36 unit minimum must be granted by the student’s Associate Dean. Undergraduates who are registered as part-time are also subject to the above deadlines to drop or withdraw from a course.

Students carrying a full-time course load as of the 10th regularly scheduled class day are not ordinarily permitted to drop below 36 units after that time. Exceptions must be authorized by the student’s Associate Dean.

Status, Class Standing

Students should refer to the sections of the catalog pertaining to their college and/or department to determine the number of units required each academic year by their specific curriculum. Students must achieve passing
grades in order to earn units; students do not earn units for incomplete or failed courses.

A freshman student becomes a sophomore after earning passing grades in three-fourths of the units required by his/her freshman curriculum.

A sophomore student becomes a junior after earning the number of units required by his/her curriculum for the freshman year plus three-fourths of the number of units for the sophomore year.

A junior student becomes a senior after earning the number of units required by his/her curriculum for the freshman and sophomore years plus three-fourths of the number of units for the junior year.

Classification of students is made only at the time of their first registration in any academic year and remains unchanged throughout the rest of that academic year.

Course Description Requests (for prior years)

Please note that University Archives does not have access to transcript and verification information. They maintain only the course description archives. If you call or e-mail this office, your request will not be processed. Please contact:

Archives/Art Inventory Specialist
Carnegie Mellon University Libraries
4909 Frew St.
Pittsburgh, PA 15213
(412)268-5021 (phone)
(412)268-7148 (fax)

Graduation & Diplomas

Degree Requirements

Students are responsible for checking to ensure that the degree requirements (as listed in the appropriate catalog at the time of their matriculation) have been met. They may also refer to the university’s online academic audit website: https://enr-apps.as.cmu.edu/audit/audit. If the degree requirements have been modified by College Council action, the student is responsible for checking to ensure that the modified requirements have been met.

In order to graduate, students must complete all residence requirements and all course requirements in their approved curriculum and be recommended for degrees by the faculty of the appropriate college. Such recommendation shall be based upon the good standing of the student in academic and disciplinary matters.

No student may receive a diploma until all financial obligations to the university have been met.

Residency Requirement

A candidate for the bachelor’s degree must complete at least 120 units of coursework at Carnegie Mellon. Some of the university’s colleges and departments have developed more restrictive requirements in this area. Students should consult that section of the catalog in which their college or department’s academic regulations are presented for the residency requirements applicable to them. Deviation from these policies requires action by the Dean of the student’s home college.

Implications of Residency Requirements for Transfer students seeking second undergraduate degree: Students who received degrees from other universities could have up to 2 years of credits earned elsewhere applied to their Carnegie Mellon degree requirements and would need to meet Carnegie Mellon’s Residence Requirement and complete at the university a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of coursework. Deviation from these policies will require action by the Dean of the student’s home college.

Diplomas

A Carnegie Mellon diploma is a student’s certificate of accomplishment. The diploma is printed with the name the student approved within Graduation On-Line, along with the student’s primary degree (i.e., Bachelor of Arts in Creative Writing). Minors are not listed on a diploma, although they do appear on an official transcript.

Diplomas are distributed to graduates during or immediately following the commencement ceremony. Certain circumstances will result in students receiving their diplomas at a later date, and such students will be informed of this well before the ceremony. If a student is unable to attend the ceremony, diplomas will be available for pick-up or mail-out in the weeks following commencement. Diplomas are not available prior to the stated date of graduation.

The diploma is 14x17 inches and is marked with a multi-colored and gold seal.

Graduation with University Honors

In recognition of exemplary academic achievement as undergraduates, some candidates for undergraduate degrees will be named to the University Honors List. Each of the undergraduate colleges will select students for honors on the basis of a cumulative grade point average (typically when cumulative GPA is greater than 3.5) and/or recommendation of the faculty.

Standard Degree Terminology

Carnegie Mellon University offers a wide variety of programs; the opportunities vary greatly between and among the colleges. For the purposes of clarification, this section defines:

• standard degree terminology;
• changes to the existing degree declaration process;
• the existing procedure for creating new degrees, majors and minors.

Degree

Examples: B.S. (Bachelor of Science); M.F.A. (Master of Fine Arts); Ph.D. (Doctor of Philosophy)

Major

Field studied in greatest depth by fulfilling a department-determined set of course requirements. The primary major is the field in which the degree is granted.

Example: Creative Writing; Physics; Marketing

Students may pursue an additional major(s) in a single degree program.

Minor

Field(s) studied for educational enrichment by fulfilling a department-determined set of course requirements. Graduate students may not pursue minors. Minors are not listed on the diploma but appear, instead, on the student’s transcript. The type of degree sought is determined by the major (that of the home department), not the minor(s). Examples: Film Studies; History of Ideas

Option

A specific area of study generally associated with a major or an additional major, which appears only on the transcript.

Home College

The college into which the student was originally admitted or into which the student formally transferred.

Home Department

The department into which the student was originally admitted or the department offering the major which the student has declared.

Concurrent College/Department

College/department other than the home college/department, granting the second of multiple degrees, or offering the additional major(s) of double or triple major, or minor.

Single Degree/Major

One diploma, stating the degree and the major field of study. Currently, the Statute of Limitations on earning an undergraduate degree is eight years.

Examples: B.A. in Psychology; M.S. in Industrial Administration

Requirements: Fulfillment of all requirements of the home college.

Declaration: At least by registration time (early November), first semester junior year.

Certification: Home college, home department

Major-Declaration Process

For undergraduates, depending on the student’s college, the major is usually declared at the end of the freshman or sophomore year. Departments enter the appropriate majors into the Student Information System upon declaration.

For graduates, the major is usually indicative of the department and is supplied by the department via SIS.
Joint Degree
Degree program offered between two or more colleges/departments or offered in conjunction with an outside University.
Examples: M.S. in Colloids, Polymers, and Surfaces (Chemistry and Chemical Engineering); B.H.A from College of Fine Arts and Humanities and Social Sciences.

Multiple Degrees
More than one degree granted by the university (whether simultaneous or sequential). One diploma for each degree. When awarded simultaneously, two degrees are referred to as dual degrees, three degrees as triple degrees. Multiple graduate degrees may be given in conjunction with (an) outside University(ies).
Examples of how such degrees appear on the respective diplomas:
• Bachelor of Fine Arts in the field of Art; Bachelor of Science in the field of History
• Bachelor of Science in the field of Physics; Bachelor of Science in the field of Computer Science

Requirements: Multiple bachelor’s degrees
Declaration: Undergraduates: at least by registration time (early November), semester junior year
To receive multiple bachelor’s degrees the student must:
• satisfy all requirements for each degree.
• complete a number of units determined as follows: the aggregate number of units must exceed by at least 90 the required number of units for at least one of the degrees. (For example: if one of two degrees requires 365 units and the other requires 380 units, a total of at least 455 units is required to obtain both degrees.)
• comply, for each degree, with the statute of limitations regarding the time at which units are earned.
• while working towards more than one degree simultaneously, designate one of the departments (and if necessary colleges) as the home college/department.

Additional Major
One degree, stating the major in the home department first and the additional major second. The type of degree given (B.A., B.S.) is determined by the major of the home department.
For example, a student whose home department is Physics:
This degree is valid: B.S. in Physics with an additional major in History
This degree is not valid: B.S. in History with an additional major in Physics
The intent of a double major is an in-depth understanding of two major fields. Students may pursue a second major in a field where the primary degree is different from the degree associated with the additional major: e.g., B.S. in Economics with an additional major in History.
Requirements: If the double majors involve two different colleges OR the same college, the student must fulfill:
• all requirements (including core) for the first major degree as defined by the home college;
• all major requirements (including core prerequisites) for the additional major;
• any specific requirements for double majors imposed by the department(s)/college(s) involved.

Declaration: At least by registration time (early November), first semester junior year.
Certification: Home college, home department; concurrent college (if any), concurrent department (if any).

Additional Majors
One degree, stating the major in the home departments first, the second and the third major afterwards. The type of degree sought (B.A., B.S.) is determined by the major in the home department.
For example, a History student, this degree is valid: B.A. in History with additional majors in Professional Writing and in Hispanic Studies. This degree is not valid: B.A. in Professional Writing with additional majors in History and in Spanish.
Requirements: If the triple major involves two or three different colleges OR the same college, the student must fulfill all requirements listed for each additional major.
Disciplinary Suspension is the result of serious personal misconduct and is imposed by the Office of Student Affairs (see The Word/Student Handbook).

Administrative Suspension is the result of failure to meet university financial obligations or failure to comply with federal, state or local health regulations and is imposed by Enrollment Services. (See Student Accounts Receivable Collection Policy and Procedures for financial obligations. Contact Student Health Services for information about health regulations.)

Suspended students may not:

- register for courses
- attend classes
- live in residence halls or Greek housing
- use campus facilities, including athletic facilities, library and computer clusters
- participate in student activities
- be members of student organizations
- have student jobs

(Note: students on academic suspension may have a summer campus job if they accepted the job before they were suspended.)

Employment

Although suspended students may not hold student jobs, students on academic suspension may, under certain circumstances, have a non-student job with the university; students on disciplinary or administrative suspension may not.

To have a non-student job, students on academic suspension must receive approval from their associate dean (undergraduate students) or department head (graduate students) to ensure that the job will not violate their suspension terms. Students in violation of this will lose their degree student status, meaning they would have to reapply for admission to Carnegie Mellon through either Undergraduate Admission or the appropriate graduate department.

Transfer Credit

Suspended students may take courses elsewhere; however, they may receive transfer credit only if their college’s and department’s policies allow this.

Appeals

To appeal any action of this policy, the student may write to the following people:

- Academic Suspension - associate dean (undergraduate students) or department head (graduate students);
- Disciplinary Suspension - dean of student affairs;
- Administrative Suspension - vice president for campus affairs, vice president for business and planning, and the dean of student affairs, in consultation with the student’s associate dean.

Returning from Suspension

In order to return from a suspension, a student must have the following approval:

- Academic Suspension - associate dean (undergraduate students) or department head (graduate students);
- Disciplinary Suspension - dean of student affairs;
- Administrative Suspension - vice president for campus affairs or his designate.

Contact

Questions concerning this policy or its intent should be directed to The HUB, x88186.

Procedure for the Appeal of Grades & Academic Actions

In the event a student believes an assigned grade or an imposed academic action is incorrect or not appropriate, the student may follow the processes outlined below to seek prompt and equitable resolution of the matter.

If a student believes a grade has been incorrectly assigned, the student should:

1. Present the case to the faculty member responsible for the course, providing all supporting data concerning the nature of the discrepancy.
2. If, after a decision is rendered, the student believes that his or her concerns have not been adequately resolved, the student may pursue a formal appeal with the department responsible for the course. To appeal to the department, a student must present a written statement detailing the grounds for the appeal with appropriate documentation to the head of the department responsible for the course. This appeal must be submitted within seven (7) days of receipt of the faculty member’s decision. The department head will provide a written decision, including the basis for it, within thirty (30) days, or as soon thereafter as practical.

3. If the student is not satisfied with the department head’s resolution, the student may pursue the appeal at the college level. To appeal at the college level, the student must present copies of all previously submitted documents and a formal letter of appeal, to the dean of the college responsible for the course. This appeal must be submitted within seven (7) days of receipt of the department head’s decision. The dean, or the dean’s designate, will review the appeal and will render a written decision, including the basis for it, within thirty (30) days, or as soon thereafter as practical.

If a student believes an academic action is inconsistent with the policies of the college or merits additional review, a student should:

1. Submit a formal written appeal, as specified in the initial academic action, to the associate dean of the college responsible for the decision, with a copy to the dean, requesting review of the action including all relevant materials to substantiate their case and support their concerns.
2. The dean of the college, or the dean’s designate, will review the appeal and issue a decision and the basis for it within thirty (30) days.

If, after carrying out the steps of either process described above, the student believes that the matter has not been adequately resolved, or if no decision has been rendered by the appropriate date, the student may appeal at the university level. To appeal at the university level, the student must present copies of all previously submitted documents and a formal letter of appeal to the provost. The provost or another designated university officer will respond in writing with a final resolution, including the basis for it, within thirty (30) days, or as soon thereafter as practical.

Other Academic Regulations

Level of English Fluency Needed for Non-Native English Speakers

To be successful at Carnegie Mellon University, students who are nonnative speakers of English need to begin their undergraduate work with a strong foundation in academic English and a high level of proficiency with speaking, reading and writing in English. The importance of English language abilities cannot be overstated since there are no basic ESL language courses at Carnegie Mellon. All students will have sufficient English language proficiency to be able to participate fully in the academic work and to interact in daily life outside of the classroom.

Students’ English fluency will enable them to handle the demands of academic work, including the ability to comprehend, process, and master complex material presented in English, both in written and spoken form. Students will possess the fluency to communicate their ideas and questions to faculty, classmates, and others, in a classroom environment that is often highly participatory. For example, many classes require group discussion, team projects, oral presentations, and/or independent research. In addition to fluent English skills, studying in a new culture requires openness and flexibility to adapt to a new, and often very different, academic system.

To assess the language of nonnative speaking applicants, a minimum TOEFL score of 600 (paper based, PBT), or 100 (internet based, iBT) has been established as the standard for admission. This minimum score indicates that an applicant has the fundamental building blocks of language needed for academic tasks and for continued language development. Since neither the paper CBT versions of TOEFL access speaking, students who took these tests should additionally seek feedback on their speaking skills and work to improve conversational skills before beginning academic work.

Exchange Students

Each term, Carnegie Mellon welcomes exchange students from partner institutions around the world. Exchange students enrich the learning experience at Carnegie Mellon and are expected to be full participants in the curricular and metacurricular life. Therefore, their admission should adhere to the English language guidelines described above. Exchange students should submit standardized English language testing scores (such as the TOEFL) as part of the Exchange application process, and present the same high level of English language abilities as degree-seeking students. With exchange students, high-level English abilities are particularly critical since academic, personal and extracurricular experiences must be maximized in a short period of time sometimes only four months in duration.
Withdrawal of a Degree

The university reserves the right to withdraw a degree even though it has been granted should there be discovery that the work upon which it was based or the academic records in support of it had been falsified. In such a case the degree will be withdrawn promptly upon discovery of the falsification.

Information for Graduates

Graduating students may wear one stole ONLY with their academic regalia. Students are certainly permitted to receive/purchase more than one stole if they are a member of multiple organizations that issue stoles and may choose to wear a particular stole to the main commencement ceremony and another to their diploma ceremony.

Graduating seniors that are a member of a club/organization that issues a pin to designate affiliation are permitted to wear more than one pin with the academic regalia in addition to one stole.

Retention of Student Work

The university reserves the right in all colleges to retain indefinitely any student work the faculty may select. All work not retained by the university must be claimed at the time specified on the bulletin boards (or other forms of communication) of the department concerned; otherwise, the work will be destroyed.

Statute of Limitations

All units required for an undergraduate degree, whether earned in residence, transferred from another institution or granted via advanced placement, must have been earned within eight years of the date on which the degree is granted. This statutory period can be extended by the Dean of the student's college under the following conditions:

- the courses taken prior to the statutory period still represent a reasonable part of the student's total academic program;
- the prior courses provide adequate preparation for courses which must still be taken to fulfill the degree requirements;
- there is a legitimate reason(s) for the student not completing the academic program within the statutory period.

A request for a waiver of the statute of limitations must be submitted to the Dean of the student's college. The request for a waiver should address all of the above conditions for an extension. For cases in which a waiver is granted, the waiver covers specific courses and is intended for a specific period during which the program must be completed.

Transitional Students

Transitional student status has been instituted by the university to assist students who have changed their minds about their original field of study or who have been judged unlikely to make satisfactory progress in their chosen field. Becoming a Transitional Student gives a student an opportunity to maintain a relationship with the home college while re-orienting academic plans and goals. It also gives a student time to explore his/her options and/or enhance admissibility to another college in the university, or to another institution. Ordinarily, a student will be permitted to register as a Transitional student for no more than one semester. Although, in exceptional circumstances, a student may be allowed to extend the status beyond one semester. A student must obtain the permission of his/her home college Associate Dean to initiate this option.

Transitional student status may be available to students upon the advice of their advisor, or upon their own request. Interested students must make an appointment with the Associate Dean of their home college to discuss this option.

Note: Students at Carnegie Mellon in good academic standing may transfer from one program to another as long as they meet curricular or artistic requirements and as long as there is space in the program into which they wish to transfer.

Process for Creation of New Degrees, Majors, or Minors

Departments proposing new degrees, majors, additional majors, and/or minors must complete a New Degree/Major/Minor Request Form. This should include any and all notations to the university diploma and/or transcript (new degrees, majors, minors, options). Departments proposing to offer a new degree, major, additional major and/or minor must follow university policies for approval as follows:

- Document the Program by completing the New Degree/Major/Minor Request Form. Departments proposing new degrees and majors must complete this form and attach course descriptions, curriculum proposal, list of present faculty who will support the Program, and verify the availability of other units' courses. This documentation must indicate the starting semester for the Program, and in the case of new majors, also indicate if it is available only as a major/additional major/minor, or in combination.
- Receive Department approval.
- Receive Dean and College Council approval.
- Submit all Program documentation complete with College Council approval to the Vice Provost for Education. New majors or degrees will not be processed without the approval of the Provost’s Office.
- Submit all Program documentation complete with College Council approval to the Vice Provost for Education. New majors or degrees will not be processed without the approval of the Provost’s Office.
- The Provost’s Office will approve or deny, and inform the sponsoring Department and Enrollment Services.
- The Department may then publicize and offer the program for student enrollment.
University Services

This page is currently being constructed. Please check back later.

Assistance for Individuals with Disabilities

Equal Opportunity Services
Whitfield Hall, 143 N. Craig Street, Pittsburgh PA 15213
http://hrweb.cmu.edu/eos.html
Everett Tademy, Director (412) 268-2012, et19@andrew.cmu.edu
Larry Powell, EOS Manager (412) 268-2013, lpowell@andrew.cmu.edu
Courtney Bryant, EOS Administrative Coordinator (412) 268-2012, cbryant@andrew.cmu.edu

Qualified individuals with disabilities are entitled to reasonable accommodations under the Americans with Disabilities Act (ADA regulations). Accommodations are determined on a case-by-case basis. Equal Opportunity Services provide links between individuals with disabilities and the campus community. Information released will provide documentation of a disability for faculty, staff, students and prospective students of Carnegie Mellon University. All information will be considered confidential and only released to appropriate personnel on a need to know basis. To access services, individuals must initiate a request in writing for specific services/accommodations (books on tape, enlargements, interpreters, etc.). Accommodations prescribed only apply to Carnegie Mellon University and may not be valid elsewhere. The individual takes full responsibility for ongoing assistance.

In order to receive services/accommodations verification of a disability according to Carnegie Mellon guidelines is required. To establish that an individual is covered under the ADA, the documentation must indicate that the disability substantially limits some major life activity, including learning. The documentation requirements are provided in the interest of assuring that a disability demonstrates an impact on a major life activity, is appropriate to verify eligibility, assures the implementation of appropriate accommodations, and supports the request for accommodations, academic adjustments, and/or auxiliary aids.

For more information on disability resources and documentation guidelines please contact Larry Powell, EOS Manager (412) 268-2013 or lpowell@andrew.cmu.edu or visit our website at http://hrweb.cmu.edu/eos.html

Carnegie Mellon Resource Advising Center (CMARC)

Ty Walton, Director
Damian Dourado, Asst. Director
CMARC Office: Cyert Hall A64, x8-2150

The Carnegie Mellon Advising Resource Center (CMARC) is an advising and information center that assists students and connects them to appropriate communities, services and opportunities by providing academic planning and one-on-one counsel. Founded as the Carnegie Mellon Action Project (CMAP), CMARC has an additional commitment to support underrepresented ethnic minority students in a setting where students’ differences and talents are guided, appreciated, and reinforced.

Academic Advising

CMARC, working in cooperation with faculty and departmental advisors, strives to promote academic success. The professional program advisors serve as an additional resource when it is necessary to consult with more than one person or to obtain another perspective. Their primary objective is to assist students in developing and achieving meaningful educational plans that are compatible with their life goals. CMARC advisors can help students:

- Establish short and long term academic goals.
- Investigate alternative majors in other colleges.
- Obtain referrals to organizations such as Career Services, Academic Development, etc.
- Explore career and graduate school options.

Computing Services

Joel Smith, Vice Provost Computing Services
Cyert Hall 283, 412-268-2638
http://www.cmu.edu/computing/

The Computing Services division develops, maintains and supports the computing infrastructure for Carnegie Mellon students, faculty members and staff members. This includes the campus wired and wireless networks, public computer labs or “clusters,” cable television and telephone services, computing related documentation and support through the Help Center. In addition, Computing Services provides standard classroom technologies for over 100 lecture halls, classrooms and seminar rooms across campus.

The Help Center
Cyert Hall 119
412-268-4357 (HELP) or advisor@andrew.cmu.edu

The Computing Services Help Center provides students, faculty members and staff members with technical assistance and information about computing at Carnegie Mellon. The Help Center staff is available Monday through Friday; phone and email support is offered 7 a.m. – 7 p.m. and walk-in support is offered 9 a.m. – 5 p.m. For help anytime, visit our extensive collection of computing related documentation at http://www.cmu.edu/computing/.

New to Carnegie Mellon
http://www.cmu.edu/computing/new-user/

Our New to Carnegie Mellon pages will walk you through the process of connecting to the campus network and provide you with other useful information about the computer resources available to you.

Computing Clusters
412-268-8776
http://www.cmu.edu/computing/clusters/

Computing Services maintains over 25 computer labs, or clusters, in various buildings across campus. Most clusters are open 24x7 during the academic year and can be reserved for teaching classes. Each location is customized with a selection of Windows, Mac or Linux computers, peripherals and printers. Included in these spaces is a state-of-the-art multimedia studio with equipment for animation and computer modeling, music composition, digital video, imaging and sound recording. Clusters also offer an extensive complement of productivity and academic software with select applications available remotely through timeshare servers and virtual desktop technology.

Computing Security
412-268-2044
http://www.cmu.edu/iso/

Computing Services Information Security Office (ISO) is responsible for directing efforts to maintain the security of data and integrity of computing devices on campus. The ISO strives to keep all university affiliates informed about the latest cyber security threats, safe computing practices and relevant information security policies and compliance issues.

Computing Policies and Guidelines
http://www.cmu.edu/computing/guideline/

The Carnegie Mellon Computing Policy establishes a general policy for the use of computing, telephone and information resources on campus. The policy is supported by a number of guidelines. Members of the campus community should be aware of information contained in the policy and supporting guidelines.

Division of Student Affairs

Gina Casalegno, Dean of Student Affairs
Warner Hall 301

As much of undergraduate education focuses on preparation for professional careers, the university is strongly convinced that the total development of the student is critical to preparation for professional practice. A great deal of time and effort by the Division of Student Affairs, faculty and the university staff focuses on providing students with the opportunities to expand experiences outside the classroom, to encounter new intellectual and social experiences, to undertake projects for personal growth, and to prepare for life.

Our vision and mission for the student experience is founded upon the intellectual, occupational, emotional, spiritual, physical, and cultural growth and nurturing of students. The Division of Student Affairs, and our partners throughout the university, are here to support you in reaching your highest potential in the areas of artistic and intellectual curiosity, personal well
being, professional competency, leadership development, and engagement in and contribution to the larger community.

Staff members throughout the division are here to support and foster your intellectual and personal growth and help you explore and experience the different aspects of college life. We care about you, your studies, your social growth, your well-being and your future and want to help you enjoy a great Carnegie Mellon experience. Offices within the Division of Student Affairs include:

- Office of the Dean of Student Affairs
- Career Center
- Counseling and Psychological Services
- Health Services
- Office of International Education
- Office of Orientation and First Year Programs
- Office of Student Activities
- Student Development Office
- Student Life Office

**Office of the Dean of Student Affairs**
Gina Casaldego, Dean of Student Affairs

The Office of the Dean provides central guidance and direction of student services at Carnegie Mellon. The dean is responsible for leading the Division of Student Affairs in providing students with quality services, programs, and experiences that support and complement the academic mission of the university.

While students are encouraged to seek out any member of the division for assistance, you may also meet with the dean of student affairs directly by calling 412-268-2075 and scheduling an appointment at your convenience.

**Career and Professional Development Center**
Farouk Dey, Director
University Center Lower Level, 412-268-2064
http://www.cmu.edu/career

Career exploration and planning
Whether you are interested in exploring post graduation options, or are clear on the direction you plan to pursue, the Career and Professional Development Center offers a complete range of resources. Students wishing to explore how majors and minors relate to career choice, as well as gain information about particular fields, will work with a career consultant to examine their skills, interests, and values and how they relate to various career fields. Career consultants also coach students in writing resumes and cover letters, networking, locating internship and job opportunities, preparing for interviews, and pursuing graduate school opportunities. Career consultants are assigned to each college and provide individualized support, general career programming, and college-specific workshops. In addition to the workshops presented by the Career and Professional Development Center staff, consultants coordinate an annual professional development series presented by prominent alumni and recruiters in various industries and fields. Finally, the Center’s library and web page provide extensive resources on job search strategies, internships, summer opportunities and other career-related interests.

Job search
Several thousand summer internships and professional full-time job opportunities are made available to Carnegie Mellon students through TartanTRAK, our on-line job listing resource. Students can access TartanTRAK through the Center’s homepage. TartanTRAK also provides information on the hundreds of employers that visit our campus each year. These organizations interview students for internships and professional employment as well as hold informational sessions in the evenings that are open to the entire campus. Average starting salaries offered to Carnegie Mellon graduates, in most fields, consistently rank above the national norms.

**Student employment/Campus jobs**
The Student Employment program promotes experiential learning and professional development. All campus job postings include learning objectives that help employers and students recognize and understand the professional and personal opportunities for growth presented by each position. The Student Employment website includes an on-line training and orientation program on topics ranging from business etiquette to the essentials of getting paid on time.

Student employment opportunities are posted on-line through TartanTRAK and include federal, state, and community service work-study jobs as well as non-work-study jobs. While having a work-study award does not guarantee a job, searching for and applying to opportunities are easily navigated through TartanTRAK.

**Counseling and Psychological Services**
Cynthia Valley, Director

Counseling and Psychological Services (CAPS) at Carnegie Mellon offers students the opportunity to talk about personal or academic concerns in a safe, confidential setting. Students come to CAPS for many reasons, including but not limited to problems with family, friends, or school; concerns about the future; and feelings of stress, low self-esteem, anxiety, depression, or loneliness.

We’re here to talk with students about issues that are significant for them. We also offer consultation to staff, faculty, and parents who have concerns about a student’s well-being. Any discussion regarding a client of the center necessitates a written consent by the student permitting us to release information, including whether the student has been seen at CAPS.

Counseling Center services are provided at no cost. There are, however, limits on the number of sessions that we are able to provide. Follow-up psychiatric services and off-campus referrals for longer term therapy are at the client’s expense. The Counseling and Psychological Services office is open weekdays, and there is a professional on call for emergencies during evenings and on weekends.

**Health Services**
Anita Barkin, Director
Morewood Gardens E-Tower, 412-268-2157
http://www.studentaffairs.cmu.edu/healthservices

Student Health Services is staffed by physicians, advanced practice clinicians and registered nurses who provide general medical care, allergy injections, first aid, gynecological care and contraception as well as on-site pharmaceuticals. Examinations by Health Services staff for illness/injury are free of charge; however, fees for prescription medications, laboratory tests, diagnostic procedures and referral to the emergency room or specialists are the student’s responsibility. Health Services also has a registered dietician and health educator on staff to assist students in addressing nutrition, drug and alcohol and other healthy lifestyle issues.

Patients are seen by appointment. Walk-in urgent care is provided. Appointments can be made by calling the office. If you have a medical problem or accident that requires immediate attention at night or on the weekend, you should contact University Police at 412-268-2323 for transportation to the emergency room. If you have an urgent problem and would like to speak with the physician on-call, you can do so by calling the Health Services number.

**Health Insurance**
In addition to providing direct health care, Health Services administers the Student Health Insurance Program. The Student Health insurance plan offers a high level of coverage in a wide network of health care providers and hospitals. It also covers most of the fees for care at Student Health Services. All full-time students are required to carry health insurance and will be assessed a charge for the individual basic mandatory plan offered through the university student health insurance program. The charge will appear on the invoice of the first semester of attendance in the academic cycle. The student is required to take one of the following three actions: (1) enroll in the basic plan as charged; (2) upgrade the benefit plan by enrolling in the enhanced student health insurance options during the open enrollment period; (3) apply for a waiver from the mandatory plan. Questions can be addressed to shinsure@andrew.cmu.edu.

Office of International Education
Linda Gentile, Director
Warner Hall, Third Floor, 412-268-5231
http://www.studentaffairs.cmu.edu/oie

The Office of International Education (OIE) is committed to supporting, promoting, and celebrating individuals in an intercultural environment. We advocate for and facilitate international and cross cultural experiences, perspectives, and initiatives. OIE is the primary contact for study abroad programs and non-immigrant matters for all students and scholars (foreign professionals and researchers) who are not United States citizens or permanent residents. OIE encourages both U.S. and international students to participate in international programs and events on campus, and we also welcome volunteers to participate and assist with programs sponsored by the office.

**Foreign Students and Scholars**
Carnegie Mellon hosts 2800 international students and 600 international scholars who come from more than 90 countries. International students make up 47% of the full-time graduate student body and 11% of our full-time undergraduates. OIE is the liaison to the university for all non-
immigrant students and scholars. The foreign student and scholar advisors provide many services including: advising on immigration, academic, social and acculturation issues, presenting programs of interest such as international career workshops, tax workshops, and cross-cultural and immigration workshops; supporting international and cultural student groups such as the International Student Union and the International Spouses and Partners Organization; maintaining a foreign student resource library that includes information on cultural adjustment, international education and statistics on foreign students in the United States; posting pertinent information to student through email and our website, and conducting orientation programs.

Study Abroad
Carnegie Mellon students in every major can spend a summer, semester, or year abroad. Over 400 students go to all corners of the globe each year and receive credit for pre-approved study abroad. There is a wide range of funding options. The study abroad office assists students in all stages of the process of going abroad. The advisors promote study abroad, advise students, work with the academic departments and conduct information sessions, pre-departure orientations and welcome back workshops. For more detailed information about Carnegie Mellon’s study abroad program, see the Undergraduate Options section of this catalog.

Office of Orientation and First Year Programs
Anne R. Witchner, Assistant Dean of Student Affairs
Morewood Gardens 388, 412-268-4887
http://www.studentaffairs.cmu.edu/first-year

The Office of Orientation and First Year Programs is responsible for providing vision and leadership for a comprehensive approach to new student orientation and transition programs. The office provides programs, opportunities and services to help students and family members successfully transition to the Carnegie Mellon community.

The office is responsible for program development, marketing and implementation of orientation and transition programs. Areas of concentration include: new student orientation, Family Weekend and special event planning.

Office of Student Activities
Elizabeth Vaughan, Director
University Center 103, 412-268-8704
http://www.studentaffairs.cmu.edu/StudentActivities/

The Office of Student Activities complements students’ academic experiences by providing services and resources that engage students in creating campus culture through social, cultural, intellectual, spiritual, athletic, recreational, artistic, political, and service opportunities. Our staff is committed to delivering quality advising, resource materials, leadership development opportunities, and administrative support services to impact students’ growth and development and enhance the success of each student organization.

Our office partners with students to create a vibrant culture of student life on the Carnegie Mellon campus. Our community is home to nearly 250 recognized student organizations that are supported by the Student Activities staff team. In addition to serving as individual advisors to many organizations and providing resources, support, and ad hoc advising to all student organizations, the office also coordinates a slate of opportunities to help Carnegie Mellon students get involved in campus life.

To learn more about getting involved on campus, please visit our website where you can find information about recognized student organizations and about upcoming events on campus. If you are interested in forming a new organization, visit our office to learn more about how to get started. We look forward to helping you make your mark on the campus experience at Carnegie Mellon.

Student Life Office
John Hannon, Associate Dean and Director of Residence Life
Morewood Gardens A-Tower, 412-268-2142
http://www.studentaffairs.cmu.edu/student-life/

The Student Life Office provides opportunities that emphasize community engagement, leadership and social responsibility while actively supporting the personal and professional development of students. To this end, we coordinate residence life for first-year, upperclass and Greek students through our house model. Our professional staff, called Housefellows, advance a broad-based vision for student development by utilizing the residential house community as a focal point for the student experience on campus. The Housefellow’s role involves serving as students’ primary metacurricular advocate at the university while enhancing their social, academic, intellectual, artistic and personal development. Students lead the development and implementation of a vibrant, engaging experience in these houses through their work as Resident Assistants, Community Advisors or house council members, all of whom are advised by the Housefellow.

Additionally, the Student Life Office coordinates a number of developmental programs, initiatives and services for the broader campus community. We coordinate educational initiatives and accountability processes related to community standards; provide resources and facilitate programs related to gender and gay/lesbian/bisexual identity including GenderTalk and OUTSpoken, the MOSAIC conference, SafeZone training and Pride Month events; advise student safety initiatives such as Sexual Assault Advisors, 1 in 4, and Safewalk; advise and support the twenty-four social, Greek-letter organizations and associated governing bodies that comprise the fraternity and sorority community; offer leadership programs such as the First-Year Leader Retreat and Emerging Leaders; coordinate spirituality and meaning-making programs such as the Big Questions series; and advise the Student Dormitory Council.

Housing and Dining Services
Kim Abel, Director
Morewood E-Tower, x8-2139
www.cmu.edu/housing-dining/

Housing and Dining Services provides a variety of accommodations for Carnegie Mellon students. Living arrangements include traditional single-gender residence halls, coeducational residence halls, suites, apartments, houses and Greek living areas. All first year students, 17 years of age or older, are required to reside in University housing. The Dean of Student Affairs must approve first-year students who wish to be exempt from this requirement and would like to commute from home. Students who will not be 17 before the start of their first semester are asked to contact the Dean of Student Affairs. Transfer student housing is subject to availability and therefore, transfer students are also asked to contact Housing and Dining Services.

University housing is available on campus and in our Oakland Community Apartments. All on-campus residential areas are located in close proximity to academic buildings. The Oakland Community Apartments are located very near the campus and are an approximate 5-10 minute walk to campus. The university’s shuttle bus services these areas on a regularly scheduled basis.

Furnishings and Amenities
Housing and Dining Services provides each resident with a bed, a desk and chair, a bookshelf, a dresser and a closet or wardrobe. Each room is also equipped with window coverings and cable TV, and all of our buildings have Ethernet or broadband service for fast data connectivity. Items such as pillows, linens, area rugs, cellular telephones (if desired), etc., are the student’s responsibility. Oakland Community apartments have a broadband service modem with one outlet per apartment. Residents are responsible for any routers or switches needed to connect multiple computers to the modem.

Room Rates
Room rates include utilities, maintenance, a cable TV jack and Ethernet/ broadband connection in each room, heating or air conditioning. Students pay separately for room and public area damages. Long distance phone access can be obtained by use of personal cell phones or calling cards purchased by the student and used at the courtesy phones.

Room Types
Residence hall rooms, apartments and houses are available through Housing and Dining Services and are priced according to these broad categories:

- Residence hall rooms
  - Grouped and priced by occupancy (# of students per room by design) and a classification (standard, prime, suite)
  - Singles, doubles, triples, and quads are available
  - No in-room cooking facilities
  - Classification is primarily based on bathroom privacy, although other criteria may also be involved
  - Standard rooms share a large, central bathroom facility
  - Prime rooms generally share a private or semi-private bathroom with no more than five students
  - Suite-style rooms share a semi-private bathroom, as well as a common living area

- Apartments
  - Efficiency, one-bedroom and two-bedroom apartments are available
  - Grouped and priced by occupancy, location, and number of bedrooms
  - In-room cooking facilities

- Houses
  - Grouped and priced by occupancy and location
• Includes bedrooms, a kitchen, a dining room, a living room, private bath and laundry facilities

Housing Reservations
Returning Student Room Selection
Each spring returning resident students will have an opportunity to reserve spaces in university housing through the Room Selection process that takes place in February and March. Returning students most often select apartments and residence hall rooms that offer more flexibility and privacy. Features typically created by a kitchen and/or semi-private bathroom facilities.

First-Year Student Room Assignments
Most first-year students are assigned to traditional residence hall rooms where each floor shares a community bathroom. Because these traditional residence hall rooms (standard rooms) support the development of strong community, they provide excellent opportunities for first-year students to form many friendships on their floor and throughout the building. While every effort is made for first-year students to share a room with other first-year students, a small number of first-year students will sometimes share a room with a returning student. If two first-year students request each other as roommates, their request will usually be honored as long as both applications are received before the May 31 deadline. Room assignments for first-year students are made in the order in which their original university deposits were processed by the Office of Admission. The Office of Admission provides Housing and Dining Services with the information concerning the date on which each incoming student deposit was processed.

Building and Room Preferences
We give our best effort in fulfilling each student’s individual housing preferences, but it is often difficult to accommodate everyone’s top choice due to the high demand for housing at Carnegie Mellon. The cost of attendance used in the calculation of a student’s eligibility for financial aid includes a housing allowance that is based on a standard double room rate. Students are still responsible for the full cost of their room rate even if it is higher than the standard double rate.

Roommate Matching Procedures
A number of factors are taken into account when we make roommate assignments: a preference for a special residential program, specific hall or room type, smoking status, and college and major. Also factored into the equation is personal information about how you intend to utilize your room (social or study purposes), how clean you intend to maintain your room and whether you consider yourself to be a “night” person or a “morning” person. Housing and Dining Services does not, and will not, discriminate in any way in regards to roommate matching. It is important for students to be honest when filling out the housing application as it will eliminate the potential for roommate conflicts.

Housing License Agreement
The Housing License Agreement is a binding document that states the terms and conditions of occupancy by which the student and the university intend to be legally bound including the dates of residence. The agreement is for two full terms, beginning with the fall semester. Housing and Dining Services advises students, parents and guardians to read the agreement thoroughly (a copy is available on our website, www.cmu.edu/housing/). The submission of the Housing License Agreement is an on-line process for both first year and upperclass students. The Housing License Agreement is signed by electronic signature and authenticated by Andrew ID through the WebSIS process.

Important Information About Temporary Housing
Because housing is in high demand at Carnegie Mellon, occupancy pressures may dictate that a limited number of first-year students spend anywhere from a few days to a few weeks in temporary housing. Once it is time to relocate to a permanent assignment, Housing and Dining Services will orchestrate and assist in the move.

Housing Charges
The housing room charge is billed in three separate amounts. After charging and crediting the housing reservation fee, the University bills students for the balance of their academic year housing charges in two separate amounts, one each semester.

Cancellations
Only under very limited circumstances can Housing License Agreements be cancelled. These reasons include marriage, verified departure from the university, study abroad, or moves to Greek housing as defined by Greek leases and approved by Housing and Dining Services staff. The only contract cancellation requests that will be considered, other than those mentioned, are those based on verifiable medical or psychological hardship.

Students interested in pursuing a contract cancellation based on one of these hardships may obtain the appropriate form at the Housing and Dining Services office.

Refunds
During the academic year, if a housing room payment should become refundable, the refund shall be recorded as a credit to the student’s account with the University. Refund amounts are calculated on a pro-rated basis for the days remaining in the contractual term after the student completes the entire withdrawal procedure, which includes completion of the Request for Cancellation form and turning the room key to the Office of Housing and Dining Services.

Other Living Arrangements
Students moving into a fraternity or sorority house or leaving university housing (except to participate in an academic program away from the Pittsburgh area) should be aware that their opportunities to move into Carnegie Mellon University housing in the future may be very limited. Students wishing to return to university housing in their senior year must complete the entire withdrawal procedure, which includes turning the room key to the Office of Housing and Dining Services.

Community Housing
Housing and Dining Services provides an off-campus housing registry service. This on-line service maintains up-to-date information on available apartments, houses and rooms in private homes for rent, as well as on students who are looking for roommates. Additional information about moving to Pittsburgh, universities, etc. is available. Since accommodations in university housing are not available to graduate students, Community Housing Services is a good resource for graduate students seeking accommodations in the local area. For more information on our services, please visit our website at http://www.cmu.edu/housing/CommunityHousing/.

Additional housing information can be found in “The Word (http://www.studentaffairs.cmu.edu/theword)”, “From the Ground Floor Up, the undergraduate guide to Housing and Dining Services” or at www.cmu.edu/housing.

Dining Services
At Carnegie Mellon Dining, our priorities are to give students healthy options, a convenient dining experience and, most importantly, good tasting, quality food. We currently feature over twenty eating locations in the University Center and in residential and academic buildings. Our cuisine ranges from Asian to Indian to American, from an all-you-care-to-eat location to breakfast served all day to a quick sandwich and drink on the go. We have established hours to meet the needs and requirements of the campus community, from early morning coffee to late night snacks. We are able to accommodate special dining needs and have a registered dietician and other food service professionals on campus that can work with individual students on nutrition and diet choices.

Dining Plans
We have designed our dining plans so that you can choose where, when and what you eat to best fit your needs. Your dining plan is encoded on your Carnegie Mellon ID card so that you have easy access to your account wherever you go.

There are several different ways to use your dining plan on campus. Our traditional dining plans and community dining plans consist of value meals combined with a declining balance account called flexible dollars. Students are also able to select a DineXtra only plan, which acts as a declining balance account for the entire semester.

Student who have purchased a traditional or community dining plan are able to use meal passes at any dining location. There are four meal periods per day - breakfast, lunch, dinner and late night. You can use one pass during each of these meal periods. The traditional plans also include two guest meals per semester which allow your guests to enjoy campus food with you, or you can use these meals if you would like to purchase two meals during one pass period. These guest meals can be redeemed at any time during the semester.

Flexible dollars and DineXtra are dollars that can be used at any point during the semester. They can be used to upgrade your meal passes with special options like Premium Entrees or to purchase items a la carte at any of our Dining locations. Flexi dollars and DineXtra can also be used at Entropy+, the campus convenience store, to purchase grocery items to supplement your daily meals. In addition to dining locations on campus, they are also accepted at East n’ Park (Murray Ave), Vocelli’s Pizza (Baum Blvd) and Subway (S. Craig St) off campus. Unused flexible dollars do not roll over to the next semester. DineXtra balances do roll over from the fall to the spring semester, but your account expires at the end of the spring semester.
Vending Services

Vending machines are located in a number of locations throughout campus. From this 24-hours service, students may chose entreés, “Healthy choice” lunch meats, soup, coffee, assorted beverages, and snacks. Many of the machines in the residence halls are enabled to accept DineXtra transactions, and most vending machines around campus also accept Piaid Ca$h.

Purchases are made by swiping your Carnegie Mellon ID Card through the card reader on each machine, which will access and deduct the cost of the purchase from your DineXtra or Piaid Ca$h accounts.

Academic Support Services
Academic Development
Cyert Hall, Suite B5
412-268-6878
www.cmu.edu/academic-development

Academic Development provides a variety of support services geared towards helping students develop the skills, strategies, and behaviors needed to perform as confident, independent, and active learners. These services range from study skills instruction in areas such as textbook reading and lecture note taking to tutoring and review sessions in selected courses. These services are free of charge and available to all Carnegie Mellon students — those who are having difficulties and those who just want to improve their skills.

Following are the services that Academic Development offers:

Peer Tutoring

Peer Tutoring is geared primarily, but not exclusively, toward large introductory courses. It is available from 8:30-11:00pm. Sunday-Thursday in various residence halls and on selected weekday afternoons in Cyert B5. This is a walk-in service, and no appointment is necessary. Standing Tutoring appointments are also available upon request.

Study Skills Instruction

Group workshops are held several times each semester, covering topics such as time management, stress management, test taking, and procrastination. Register for workshops or make individual appointments by contacting Academic Development.

Supplemental Instruction (SI)

Supplemental Instruction (SI) is an academic enrichment program that is offered in traditionally difficult courses. SI discussion and review sessions are facilitated by trained student SI Leaders who have already completed the course and received an A in it.

Designed to supplement — not replace — class lectures and recitations, SI sessions are interactive and collaborative. Students who attend sessions learn to integrate how to learn with what to learn.

SI sessions are usually held twice weekly for one hour; additional sessions are held prior to exams. Attendance at sessions is voluntary.

Study Groups

Organized Study Groups are available in selected courses each term. The Study Groups are limited to six students and are facilitated by a student leader. Come in to the Academic Development office in Cyert Hall, Suite B5 and fill out a Request Form to join a Study Group.

Fact Fast

These pamphlets, which offer tips on a variety of academic success issues, can be picked up from the Academic Development office or can be viewed on the website under “Publications”.

Freshmen Fact Fast

This set of five brochures is geared primarily toward freshmen. They cover topics such as working with faculty, optimizing your time, managing coursework and readings, understanding grades, academic integrity, and getting help when you need it.

Teacher Certification

Carnegie Mellon students interested in earning teacher certification can participate in a 5-year program that will allow them to earn their undergraduate degree at Carnegie Mellon and spend one year in an intensive Master of Arts in Teaching (MAT) program at Chatham University to earn the MAT and Pennsylvania Teacher Certification. To make this program possible, interested undergraduate students should plan to cross register at Chatham for 63 units of required courses, using elective spaces in their schedule. Students who will graduate after December 2012 will have slightly different requirements because of changes being made to more adequately meet the requirements of the No Child Left Behind law (mainly related to preparation to work with special education populations and students who speak English as a second language).

Criteria for admission or the MAT program includes: An overall GPA of 3.0, and completion of three pre-professional Praxis exams in Reading, Writing and Mathematics. All candidates for initial certification in Pennsylvania must have earned at least a baccalaureate degree, completed an approved program of teacher education, and passed The Praxis content tests for their certification area. NOTE: Pennsylvania has signed interstate agreements with more than 42 other states, so you are not restricted to teaching in Pennsylvania. Check with the Department of Education in the state where you will live to determine if PA certification will be accepted. To plan early, contact Judith Hallinen, Assistant Vice Provost for Educational Outreach, 8-1498.

Intercultural Communication Center

Peggy Allen Heidish, Director
Warner Hall 308, (412) 268-4979
http://www.cmu.edu/icc
esihelp@andrew.cmu.edu

The Intercultural Communication Center (ICC) is a support service offering both credit and non-credit classes, workshops, and individual appointments designed to equip nonnative English speakers (international students as well as students who attended high school in the U.S.) with the skills needed to succeed in academic programs at Carnegie Mellon. In addition to developing academic literacy skills such as speaking, reading and writing, students can learn more about the culture and customs of the U.S. classroom. The center offers:

• Writing Clinic: individual appointments to help students with their academic writing assignments
• Credit class for undergraduates: Building Fluency for Presentations (7 week mini, 99-451); register through ICC, interview required
• Non-credit Seminars and workshops: such as Citing Sources, Writing Academic Summaries and Revising for Clarity
• Tutoring: individual appointments address specific areas such as speaking, listening, grammar, and academic fluency
• Placement interviews: evaluate spoken language so that we can suggest appropriate ICC work and give students useful feedback on the strengths and weaknesses of their communication skills.
• The ITA Test: a mandatory screening test for any non-native speaker of English (graduate or undergraduate) who plans to work as a teaching assistant.

Level of English fluency needed for non-Native English speakers — Please see Academic Regulations. (p. 42)

Fellowships

Fellowships and Scholarships Office (FSO)

Stephanie Wallach, Director
Jennifer Keating-Miller, Assistant Director
Neslihan Ozdoganlar, Fulbright Advisor
http://www.cmu.edu/oso
Phone: 412-268-9987

Students at Carnegie Mellon are encouraged to apply for a wide variety of national and international fellowships available throughout their undergraduate years and post graduation. These opportunities — some more competitive than others — open up a diverse range of experiences, exposing students to new scholarly communities, to different kinds of research, and/or service in the public sector. Participation in scholarships, fellowships, and other award opportunities is often an important springboard to future career directions. Many people have heard about the Rhodes Scholarships, the Fulbright Grant and The Harry S. Truman Scholarship, yet there are hundreds of opportunities that may be less well-known but are excellent funding sources.

The Fellowships and Scholarships Office plays an important role in helping students learn about scholarships that are a good match for their interests. The FSO staff also work closely with students on their applications to make sure that they are as competitive as possible.

Please visit the FSO website to learn about the many scholarships and fellowships open to Carnegie Mellon students. The website also contains useful links to other resources for additional information on external educational opportunities.
Honor Societies

Phi Beta Kappa Society

Website: http://www.cmu.edu/pbk

Carnegie Mellon shelters a chapter of the Phi Beta Kappa Society, sponsored by the three colleges (Dietrich College of Humanities and Social Sciences, Mellon College of Science, and the School of Computer Science) that comprise the University’s “arts and sciences” equivalent. The chapter’s name is “Upsilon of Pennsylvania,” and was formally installed in April of 1995.

Founded in 1776 at the College of William and Mary in Williamsburg, Va., Phi Beta Kappa is the nation’s oldest honorary society, with chapters at 276 of the foremost institutions of higher education across the country. Almost all members are elected by the chapters from among candidates for degrees in liberal arts and sciences, usually from the top 10% of the graduating class.

Many notable figures in American history have earned the coveted Phi Beta Kappa key including leaders of the American Revolution, delegates to the Constitutional Convention of 1788, and members of the Continental Congress and the U.S. Congress. Six United States presidents earned the honor as undergraduates and another 10 presidents were elected as alumni or honorary members.

Membership in Phi Beta Kappa key has become a universally recognized mark of academic achievement in the liberal arts and sciences. The key’s venerable pointing finger proclaims for all to see the wearer’s commitment to Phi Beta Kappa’s ancient principles (represented in the three stars) — friendship, morality and learning.

The society’s name is formed by the first letters of the phrase Philosopha Bate kappainmetes. Philosophy (wisdom) is the Guide of Life. In line with the conviction that the test of education lies not in what people know but in what they are, the objectives of humane learning encouraged by Phi Beta Kappa include not merely knowledge but also intellectual honesty and tolerance, a broad range of intellectual interests and understanding.

The Carnegie Mellon chapter is active in sponsoring visiting speakers, on-campus roundtables that focus on current issues, community service activities, scholarship opportunities, student research involvement, and the like.

The Honor Society of Phi Kappa Phi

The Honor Society of Phi Kappa Phi has been an important presence on campus since 1933. Phi Kappa Phi, a national honor society that began in 1897 at the University of Maine, takes its name from the initial letters of its adopted motto, Philosopha Krateito Photon, “Let the love of wisdom rule.” Phi Kappa Phi recognizes and honors persons of good character who have excelled in scholarship, in all fields of study. Members are nominated by their department or their school or college and then invited to join the society. To be eligible, seniors must be in the top ten (10) percent of their class and juniors in the upper seven and one-half (7.5) percent of their class at the time of invitation. Graduate students, alumni, faculty and staff are also eligible for nomination. The chapter inducts new members once a year, each spring, and provides information to its members on all sorts of opportunities, including study abroad, internships, and graduate fellowships, recognition and awards.

Undergraduate Research Office

Stephanie Wallach, Assistant Vice Provost for Education
Jennifer Keating-Miller, Assistant Director of Undergraduate Research and National Fellowships
Jennifer Weidenhof, Program Coordinator
www.cmu.edu/uro

What is the Undergraduate Research Office (URO) at Carnegie Mellon?

Conducting research as an undergraduate is a terrific way to get to know faculty members, explore an area of interest in depth, turn classroom theory into practical hands-on experience, get a feel for graduate school, and have some fun at the same time! The Undergraduate Research Office supports students conducting independent research and creative projects in every field at the university.

All undergraduates at Carnegie Mellon are eligible to participate in Undergraduate Research Office programs. The term “research” is defined broadly as “research, scholarly, or artistic activities that lead to the production of new knowledge; to increased problem solving capabilities, including design and analysis; to original critical or historical theory and interpretation; or to the production of art or artistic performance.” Students from all fields and at all levels are encouraged to participate in the research process at least once, and hopefully many times, in their undergraduate careers. Our website, www.cmu.edu/uro contains detailed information on all of our programs and on the application processes.

Advising and Information Services

The Director and Assistant Director of the Undergraduate Research Office are available to discuss project ideas; suggest possible faculty mentors (required); read and comment on proposal drafts; and generally facilitate the research process. In addition, the URO typically runs two proposal writing workshops each semester to assist students in preparing their proposals. Support from the URO is a competitive process and requires the students to submit strong proposals.

Small Undergraduate Research Grants (SURG)

Undergraduates in good academic standing are eligible to apply for a Small Undergraduate Research Grant (SURG). Awards are made twice each year based on submitted project proposals. A panel of faculty and administrators from each of the colleges serves on the selection committee and will generally consider requests up to $500 for individual student projects or $1000 for a group project. Grants may be used to purchase supplies and materials, rent time on laboratory equipment, pay subjects in an experiment, or even travel to another city to collect data. Budgets are required as part of the SURG proposals. Deadlines are October for the Spring grant period and in March for the Summer and Fall grant periods.

Summer Undergraduate Research Fellowship (SURF)

These fellowships are designed to allow students a 8–10 week summer of supported research at Carnegie Mellon in close collaboration with a faculty advisor. Students receive a fellowship of $3,500 as a stipend to cover any of their expenses. The deadline for submission of proposals coincides with the regular SURG deadline in March.

Undergraduate Research Symposium: Meeting of the Minds

The undergraduate research symposium, known as “Meeting of the Minds,” is an annual event that brings our campus together to celebrate the diverse, creative, and ground-breaking research that takes place among undergraduates. Students share their research findings through poster, oral, and artistic presentations. Many participate in award competitions sponsored by various corporations, individuals, and organizations. All students funded through the URO are required to attend, but it is also open to other students, including senior thesis presenters. Approximately 450 students participate each year. Meeting of the Minds takes place during early May at the University Center.

Presentation Awards

Students whose work has been accepted for presentation at an academic conference are eligible to apply for a Presentation Award. These awards, up to $250, help defray costs of conference registration, transportation, and accommodation.

SRC-UR0 Program

Second-year students in semiconductor research and information technology fields are eligible to join faculty labs — depending on the needs of the faculty and qualifications of the student — to get an early taste of the excitement and benefits of undergraduate research. The Semiconductor Research Corporation (SRC) funds this program. Students can earn up to $2,000 per semester for the second semester of their sophomore year and for both semesters of their junior year; they are strongly encouraged to apply for SURF ($3,500) for the summer between their sophomore and junior years. SRC-UR0 is open to students in the following fields: Electrical and Computer Engineering; Chemical Engineering; Mechanical Engineering; Materials Science and Engineering; Computer Science; and Physics. This is a competitive opportunity and the number of participants is very limited. A special application process is required and is available on the URO website.

University Center

Carnegie Mellon’s University Center is the first building of its kind on our campus. A central gathering place for all members of the university community, the University Center is the hub of Carnegie Mellon’s social, athletic, recreational and religious life.

- Play basketball, volleyball and badminton
- Play racquetball or squash on one of five courts
- Swim in the eight-lane lap pool or dive into the diving well
- Work out on new weight machines, rowers, stair climbers, ellipticals, and treadmills
- Take a group exercise class including yoga, indoor cycling, Pilates, and Zumba. Check the website www.cmu.edu/athletics/facilities/university-center.html for further information.

The locker rooms include showers, whirlpools, and steam rooms.
Undergraduate Academic Advising

Carnegie Mellon recognizes the vital role of academic advising in undergraduate education. The university assigns an academic advisor to each student, and makes certain that all advisors have clear, timely, and accurate information concerning programs, policies, procedures, and resources. In addition to having assigned academic advisors, students often develop relationships with faculty and staff members who serve as academic mentors.

Institutional Statement on Advising

Academic advising is integral to the educational mission of Carnegie Mellon. Advising is an intentional process, grounded in teaching and learning, and provides each student with guidance for developing and achieving meaningful educational, professional, and personal goals. Successful advising at Carnegie Mellon depends upon a shared understanding of, and commitment to, the advising process, by students, advisors, and the university. Academic advisors engage students in learning, promote students’ academic success, and foster students’ personal, ethical, and intellectual growth, all of which will carry into their roles as citizens and lifelong learners.

The Student’s Role in Academic Advising

Seeking advice is an important part of how students begin to make decisions about their academic and professional futures. Each major and department has an advising system which may be different from one another. It is important that students find out early from their first year advisor how the advising system for all their four years at Carnegie Mellon works.

Students are responsible for: understanding the importance of their relationships with advisors; seeking out advisors, contacts, and information on a regular basis; knowing the requirements of their individual degree programs; and taking final responsibility for making their own decisions based on the best information and advice available. The Carnegie Mellon Advising Resource Center (CMARC) is an additional place for students to obtain information and general advice.

The Advisor’s Role

To achieve the goals of academic advising at Carnegie Mellon, advisors, along with their advising programs, are responsible for: being knowledgeable of, and communicating, the requirements of the academic programs in which they advise; monitoring students’ progress towards degree completion; being available to meet with students on a regular basis; assisting students in finding the appropriate institutional and community resources; involving students in the academic and career planning process and the exploration of options and resources; and engaging in developmental activities to stay informed of issues that impact student success.

University Police

Director: Thomas Ogden, Chief
Office: 300 South Craig Street, Room 199
Public entrance on Filmore Place
www.cmu.edu/police

The University Police Department consists of 24 sworn Police Officers, 37 Security Guards, and five Communications Dispatchers. University Police provides campus buildings and grounds patrol, emergency medical transport, personal escorts, and other services to increase the safety and well being of persons and property in the university community. Officers patrol the campus continuously 24 hours a day, seven days a week on foot, on bicycle and in vehicles and remain in constant radio contact so that they can respond rapidly in the event of an emergency. Direct line emergency telephones to the University Police communications center are located both inside and outside of buildings at 53 locations around the campus.

All crimes that occur on campus should be reported immediately to University Police to ensure that appropriate action is taken. Crime occurring on campus can be reported in person, or by calling the University Police emergency number, (412) 268-2323 or x8-2323, any time of the day or night. All other non-emergency inquiries should be made by calling the non-emergency number (412) 268-6232 or x86232.

University Police operates an Operation Campus Watch program to increase the awareness of the entire community at Carnegie Mellon. The concept of Operation Campus Watch includes two simple aims:

1. The sharing of crime information by University Police.
2. The involvement of the entire community in reporting suspicious activity or actual crime.

Additional information on Operation Campus Watch is available at the University Police Office located at Room 199, 300 South Craig Street or by calling the non-emergency number, (412) 268-6232.

All emergencies on campus, including fire and medical, should be reported immediately to University Police.

Students are responsible for their personal property as well as the property of groups to which they belong. Insurance against loss, theft, or damage to such property occurring in the residence hall or elsewhere on campus must be arranged for by students or their parents through an insurance agent.

University Police makes available on the world wide web a wide range of information about the university’s security practices. Descriptions of crime prevention programs, alcohol and drug, sexual assault policies, and statistics about the number and type of crimes committed on campus during the preceding three years can be found at www.cmu.edu/police, click on “Annual Reports.”

University Libraries

Gloriana St. Clair, Dean of University Libraries
Office: Hunt Library / 412-268-2447 / gclair@andrew.cmu.edu
www.library.cmu.edu

Facilities and Services

The University Libraries’ collections support teaching and research at Carnegie Mellon University (CMU). The collections for various disciplines are housed in three libraries: the Engineering and Science Library (engineering, mathematics, physics, computer science and robotics), Hunt Library (humanities, fine arts, social sciences and business) and the Mellon Institute Library (chemistry and biology). An off-site storage facility holds low-circulating materials, which are available at your request via the library catalog. Interactive access to library resources is supported by the University Libraries’ home page at http://search.library.cmu.edu.

Reference services help you to select resources and find the information you need. If you need materials that we do not own, interlibrary loan will help you to obtain them. Circulation services help you to borrow and renew materials, and use course reserves. Most course reserves are online, but some reserves are hard copies that faculty set aside in the library for their classes to use.

The University Libraries also house several unique collections (Architecture Archives, Fine and Rare Books, and the University Archives) in addition to a number of special collections that we have digitized and make available online. Digital collections include the H. John Heinz III Archives, the Allen Newell Collection, the Clifford Shull Collection, the Herbert Simon Collection, the Joseph Traub Collection, and the Posner Family Collection of fine and rare books. Student-created exhibits of fine and rare books from the Posner Collection are a regular feature in Posner Center, located between the College of Fine Arts and the Tepper School of Business.

Eating at the University Center

We’ve brought in several outside vendors to offer a variety of dining options:

- Bento Bowl
- East Street Deli
- Entropy (A convenience store)
- Evegfectos
- Kosher Komer
- On-the-Go
- Schatz Dining Room
- Showcase Salads
- Si Senor
- Skibo Cafe
- Sushi Two

Shopping at the University Center

Carnegie Mellon’s retail stores are in the University Center. These include the Art Supply Store and the University Shoppe, a multi-level retail facility for art/engineering supplies and tools, books, textbooks, clothing, memorabilia and the computer store.

The building houses student organization offices, activity space and the Scotland Yard gameroom. The gameroom includes pool tables, foosball, ping pong and shuffle board. The building also includes the Student Activity staff offices, a gallery/exhibit area, webstations and printer, a multi-denominational chapel, a prayer room, the University Post Office, a recycling room, FedEx Kinkos, ATMs, PNC branch bank, the Career Center and an alumni lounge, which is open to all members of the university community.

University Services

50
Online Access

From the Libraries’ home page, search.library.cmu.edu:

- CAMEO library catalog – Use CAMEO to find out where materials are located in libraries on campus. See whether items are checked out, on reserve, or available to be borrowed.
- My Library Account – Renew books, put books on hold, see a list of what you have checked out, see fines.
- Course Reserves – Find required materials that your professors have reserved for classes to use.
- Research Help – Learn about key resources in your subject area, including the CMU librarian who is a subject specialist for your school or college.
- Ask Andy – Interactive reference service staffed by CMU librarians (chat, IM, email, phone, or in-person)
- AND MUCH MORE: Library Collections – Articles & Databases – E-Journals A-Z – Library Catalogs – Library Services ...

“Library Catalogs” links to online catalogs for the University of Pittsburgh Library System, The Carnegie Library of Pittsburgh, and other local libraries. We are partners with Pitt and The Carnegie; you can get library cards and borrow directly from these nearby libraries.

Instruction and Help – Live!

Get acquainted with the collections and services that support your school and subject area. Take advantage of library orientations and other library instruction classes that will help you become adept at using information resources. Being able to select good sources, access information efficiently, and evaluate results are skills that you will use throughout your academic and professional career.

Reference desks at the Engineering and Science Library, Hunt Library, Mellon Institute Library and in Arts and Special Collections (at Hunt Library) are staffed weekdays, evenings, and on weekends. Besides helping you in the library, reference staff also can answer your questions about remote access (using library resources such as databases and e-journals from any internet location).

If you need specialized reference help, contact the librarian for your subject area. Librarians work directly with faculty and students in each school, department and institute at CMU to help shape library collections, teach library research skills, and assist efficient research.

Undergraduate Jobs

The University Libraries hire many undergraduate students each year, primarily through state and federal work/study programs. Working part-time in the library gives you the unique opportunity to learn and practice skills that will contribute to academic success while you earn some spending money. If this sounds interesting to you, check out About Us > Employment> Student Assistants at search.library.cmu.edu and apply.
Undergraduate Options

This page describes some of the many options of study students can choose during their undergraduate career at Carnegie Mellon.

Additional Majors/Dual Degrees

Students interested in pursuing more than one area of study are encouraged to consider an additional major or dual degree. Students who complete an additional major will earn a single degree in two areas. Generally, it is possible to fulfill the requirements of both majors in four years by taking the course requirements of the second major in the elective spaces allowed by the first major. Students in Carnegie Institute of Technology may elect to double major in Engineering and Public Policy or Biomedical and Health Engineering, which are offered only as an additional major. Human Computer Interaction is also offered only as an additional major.

Dual Degree programs allow students to earn two degrees. Students who are interested in an additional major or dual degree are encouraged to review the specific possibilities with the relevant academic advisor.

Five-Year Bachelor’s/Master’s Programs

Qualified undergraduates may apply to one of several programs to earn their bachelor’s and master’s degrees in five years. For further details about these programs, please refer to the appropriate college or departmental section(s).

Carnegie Institute of Technology

The five-year Integrated Master’s/Bachelor’s programs offered by the Departments of Electrical and Computer Engineering and Civil and Environmental Engineering offers students superior technical preparation for careers in industry. The Departments of Chemical Engineering and Mechanical Engineering also offer fifth year/Accelerated Masters programs. The Department of Materials Science and Engineering offers a cooperative Industrial Internship Option in which students alternate coursework with practical experience in industry. Admission is highly competitive and leads to a Master of Science degree.

Dietrich College of Humanities and Social Sciences

The Department of Philosophy offers a bachelor’s/master’s degree option: the Bachelor’s/Master’s degree in Logic and Computation. The M.A. in Teaching English to Speakers of Other Languages (TOESL) is a fifth year master’s option for Modern Language students who are concentrating in English as a Second Language. Also, the department of English offers an accelerated program for undergraduates to obtain a Master of Arts in Professional Writing.

H. John Heinz III College

The Heinz College’s Accelerated Masters program allows qualified undergraduate students to earn a prestigious Master of Science degree in Public Policy and Management. For students in the College of Fine Arts or the Bachelor of Humanities and Arts degree program who are interested in careers in arts management, the program leads to a Master of Arts Management degree.

Mellon College of Science

The Honors Programs in the Departments of Chemistry and Mathematics are demanding, accelerated programs that give highly qualified students the opportunity to earn their bachelor’s and master’s degrees in just four years. Admission is by invitation only.

Tepper School of Business 3-2 Program

Students who are interested in business management may wish to consider the Tepper School of Business 3-2 program. Qualified undergraduate students may earn their master’s degree in Industrial Administration in addition to their bachelor’s degree. For students interested in earning a Master of Science in Quantitative Economics degree, Tepper offers an accelerated B.S./M.S. program in Economics.

Health Professions Program

Director: Justin C. Crowley, Ph.D.

Office: Doherty Hall 1319

The Health Professions Program (HPP) at Carnegie Mellon University is an advising and resource center for all university students and alumni who are interested in one or more aspects of the health professions. This program complements a student’s curricular advising and is meant to help students explore their interests, prepare for graduate programs in the health professions, and facilitate their application process. Students can enroll in the program at any time during their academic career, but the importance of early planning is communicated to interested first-year students. Once enrolled, students meet regularly with the director to discuss course requirements, medical exposure opportunities, and other aspects of preparing to be a competitive candidate.

Students in the HPP span all colleges of the university and have many diverse career interests including medicine, dentistry, optometry, biomedical research, medical physics, rehabilitation engineering, medical informatics, and health policy. Although the majority pursue a primary major in the Mellon College of Science, other highly represented disciplines include engineering and the social sciences.

Regardless of a student’s major, the basic course requirements outlined below must be completed prior to medical school matriculation, and most should be taken before the student takes the Medical College Admissions Test (MCAT) that is normally taken in spring of the junior year:

1. One year of general biology with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-230</td>
<td>Intro to Mammalian Physiology</td>
<td>9</td>
</tr>
<tr>
<td>or 43-202</td>
<td>Physiology</td>
<td>9-12</td>
</tr>
<tr>
<td>03-124</td>
<td>Modern Biology Laboratory</td>
<td></td>
</tr>
<tr>
<td>or 03-343</td>
<td>Experimental Techniques in Molecular Biology</td>
<td></td>
</tr>
<tr>
<td>or 03-206</td>
<td>Biomedical Engineering Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

2. One year of general chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

3. One year of organic chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>09-222</td>
<td>Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

4. One year of physics with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-106-111</td>
<td>Physics I for Engineering Students (for science or engineering students)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>33-112</td>
<td>Physics II for Science Students</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>33-100</td>
<td>Basic Experimental Physics</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

5. One year of English.

This is typically fulfilled by the following Carnegie Mellon courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>76-xxx</td>
<td>English course of the student's choice, typically 200-level or higher</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to these general course requirements, recommended coursework includes calculus, biochemistry, statistics, behavioral sciences, ethics, and languages. Interdisciplinary studies are also strongly encouraged, and many students design an undergraduate curriculum that incorporates majors and/or minors in both the natural and social sciences. One interesting interdisciplinary minor offered is the Minor in Health Care Policy and Management, which broadens awareness of the health care field from social, economic, historical, and policy perspectives. See http://coursecatalog.web.cmu.edu/melloncollegeofscience/melloncollegeofscienceseminors/ for the details of this minor.

Undergraduate research is a hallmark of the educational experience at Carnegie Mellon in many disciplines. Whether in the psychology lab studying the impact of breast cancer diagnosis on family social dynamics, in the NMR lab imaging metabolic function in the heart or brain, or in the surgery suite testing robotic devices, our students have made significant achievements in research, well beyond the more traditional guided experiments.

Our university policy is to train students to be first class scientists, engineers, artists, writers, managers, or whatever their passion may be. We do not train students to be “pre-med,” but if they choose to use their
talents in a health profession, we offer many services to help them obtain their life goals. Regular advising, application workshops, health issue seminars and symposium, community outreach activities, and preceptorship/internship experiences are all part of our programming. The student pre-health organizations on campus, the Doctors of Carnegie (DOCS) and the Minority Association of Premedical Students (MAPS), together with the Health Professions Program, provide students with many opportunities to learn, explore, and prepare for their chosen area of professional interest.

The Health Professions Program has been successful in helping students to define, prepare for, and obtain their professional goals. Our students are regularly accepted at top-level medical and graduate programs, and our alumni continue to serve as outstanding ambassadors of Carnegie Mellon and the training and experience they received here.

Minors
In addition to a student’s primary degree, he or she can choose a minor, a secondary focus to the student’s area of study, which can enhance a student’s breadth of study and overall experience while not requiring the same amount of coursework as a second major or degree. The following list shows available minors. Unless otherwise indicated, minors are generally open to all university undergraduate students.

Intercollege:
- Arts in Society (sponsored by the Center for Arts in Society)
- Health Care Policy and Management (sponsored by the College of Humanities and Social Sciences, the H. John Heinz III College, and Mellon College of Science)
- Music Technology
- Neural Computation

Carnegie Institute of Technology:
The following CIT minors are open to all Carnegie Mellon students:
- Biomedical Engineering
- Engineering Studies
- Technology and Policy
- Robotics

Designated Minors (open only to CIT students):
- Audio Engineering
- Automation and Controls
- Colloids, Polymers and Surfaces
- Data Storage Systems and Technology
- Electronic Materials
- Environmental Engineering and Sustainability
- Global Engineering
- Manufacturing Engineering
- Materials Science and Engineering
- Mechanical Behavior of Materials

The College of Fine Arts:
- Accompanying (available only to Piano majors in the School of Music)
- Architectural Representation and Visualization (available also to B. Arch candidates)
- Architectural Technology
- Architecture
- Architecture History (available also to B. Arch candidates)
- Art
- Building Science (available only to B. Arch candidates)
- Communication Design
- Conducting (available only to students in the School of Music)
- Drama
- History of the Arts
- Industrial Design
- Music
- Music (Composition) (available only to students in the School of Music)
- Music Education (available only to students in the School of Music)
- Music Performance (available only to students in the School of Music)
- Music Technology
- Music Theory
- Photography

Dietrich College of Humanities and Social Sciences:
- African and African American Studies
- Chinese Studies
- Cognitive Neuroscience
- Creative Writing
- Economics
- Economics, Innovation, and Entrepreneurship
- English
- Environmental Studies
- Ethics
- European Studies
- Film and Media Studies
- French and Francophone Studies
- Gender Studies
- German Studies
- Global Systems and Management
- Health Care Policy and Management
- Hispanic Studies
- History
- Japanese Studies
- Linguistics
- Logic and Computation
- Philosophy
- Policy and Management
- Professional Writing
- Psychology
- Religious Studies
- Russian Studies
- Science, Technology and Society
- Sociology
- Statistics
- Technical Writing

Mellon College of Science:
- Biological Sciences
- Chemistry
- Computational Finance
- Discrete Mathematics and Logic
- Environmental Science
- Mathematical Sciences
- Neuroscience
- Physics
- Scientific Computing

School of Computer Science:
- Computational Biology
- Computer Science
- Human-Computer Interaction
- Language Technologies
- Robotics
- Software Engineering

Tepper School of Business:
- Business Administration
- Business Administration (for CIT students)

Pre-Law Advising Program
Director: Joseph Devine, Associate Dean for Undergraduate Studies, Dietrich College
Office: Dietrich College Dean’s Office, Baker Hall 154
www.cmu.edu/pre-law

“Law School” is an objective that students frequently mention when asked about post-baccalaureate plans. It seems in its brevity to be a simple enough answer, but in reality it masks a host of complex and momentous personal decisions and strategic tasks.

First and foremost, seeking entry into law school implies an informed decision about the rigors of law school and the realities of professional life
as an attorney, as well as a strong and mature commitment to achieving these objectives at significant cost and investment (financial, personal, and intellectual). Second, it implies an understanding of the prolonged sequence of steps involved in the process of selecting law schools to which to apply, actually applying, ultimately selecting a school to attend, financing a law school education, and succeeding in law school. Finally, it implies an understanding of this as one of many options that should be carefully considered before a choice is made that will so significantly influence the course of one’s personal and professional life.

To address these needs, the university offers a pre-law advising program for students and alumni/ae who are contemplating or actively seeking to enter law school. The program consists of a range of support services, coordinated centrally, designed to assist these groups in engaging the complex questions associated with decisions about law school, and in successfully negotiating the sequence of tasks associated with selecting, applying and gaining admission to the best law schools possible.

The emphases of this program are:

• early identification of pre-law candidates;
• stimulation at early stages and throughout this process to consider the essential questions of personal suitability for law school and professional life as an attorney;
• engagement with meaningful substantive issues rooted in the law that illustrate the intellectual complexities of our legal system and the corresponding intellectual acumen needed to enter and thrive in this profession;
• timely direction in designing and executing a well-planned law school research, selection and application strategy;
• gathering and using accurate data on university alumni entering law school and the legal profession.

The program proper consists of several components, organized and made available as an ongoing service to all students and graduates of the university. These components include periodic workshops and seminars, a pre-law web site, a pre-law newsletter, and linkage with law school admissions offices, the Law School Admissions Council, and associations (both regional and national) of pre-law advisors. The program also works closely with the student Pre-law Society.

Two early admission options are available to Carnegie Mellon undergraduates interested in either of Pittsburgh’s two law schools: the Duquesne University School of Law, and the University of Pittsburgh School of Law. Requirements and procedures vary for each option. Interested students should meet with the university pre-law advisor before the end of their junior year.

Department of Athletics & Physical Education
Please see http://coursecatalog.web.cmu.edu/servicesandoptions/departmentofathleticsandphysicaleducation/

Reserve Officers’ Training Corps (ROTC)
Please see http://coursecatalog.web.cmu.edu/servicesandoptions/rotc/

Study Abroad
Carnegie Mellon students from every major can study in any part of the world for a semester, year or summer. Short-term programs during spring and winter break are also possible. A well-planned study abroad program will allow a student to receive credit for study abroad and graduate on time. Most students study abroad during their junior year; however, a growing number of students are studying abroad during their sophomore and senior years.

The study abroad advising staff offers general information sessions as well as individual advising appointments to assist students in all stages of the study abroad process. The Office of International Education (OIE) has a large in-house library as well as useful web links to help students find the most appropriate study abroad program. In addition, OIE offers orientations to help with personal, academic and acculturation issues, before and after a study abroad experience.

Carnegie Mellon offers students a variety of payment options for study abroad to allow students to study abroad regardless of financial need. There are three categories of programs: Exchange Programs, Sponsored Programs, and External Programs. A description of each program follows. More detailed information can be found at www.cmu.edu/studyabroad.

Exchange Programs
Students who participate in exchange programs pay Carnegie Mellon tuition and receive their regular financial aid package. Students are responsible for room, board, travel and miscellaneous expenses.

University Exchanges
Carnegie Mellon University has university-wide exchange programs with institutions located in Australia, Chile, Hong Kong, Israel, Japan, Mexico, Qatar, Singapore, and Switzerland.

Departmental Exchanges
Architecture, Art, Chemical Engineering, Design, Drama, Electrical and Computer Engineering, English, Heinz College, Information Systems, Materials Science and Engineering, Modern Languages, Computer Science and Business offer departmental exchange programs. Students should contact their department or the study abroad website for additional information.

Sponsored Programs
The university has designated a few study abroad programs administered by other organizations or universities as sponsored programs. To participate in these programs students pay a university fee equivalent to current tuition, room and board, and retain their eligibility for all financial aid. Carnegie Mellon in turn pays the program costs to the study abroad sponsor. Where applicable, funds are distributed to the student for room, board, travel, and personal expenses.

Currently Carnegie Mellon has 38 sponsored programs available around the world. A full list can be found at www.cmu.edu/studyabroad or in consultation with a study abroad advisor.

External Programs
Students may also participate in a program sponsored by another university or study abroad organization if the student’s home department approves the program and its course offerings. Students will pay the other organization or institution directly. Students who receive institutional aid from Carnegie Mellon will not be eligible for this aid while they are abroad. However, students with state and federal aid will still qualify. Students can learn more about external program options during study abroad advising appointments and by exploring the study abroad website and library.

University Student-Defined Major
Carnegie Mellon offers the opportunity for undergraduate students to pursue a University Student-Defined Major. (There are also opportunities to pursue a Student-Defined Major in some of the colleges [see relevant college section of the catalog]). For information and advice, interested students are encouraged to speak to the Associate Dean (sic) of their current home college or the college most relevant to the proposed course of study. The requirements for successful completion of a University Student-Defined Major include a student proposal approved by an advisor, relevant college(s), and the Provost, and successful completion of the approved course of study. In brief:

• A student interested in pursuing a university student-defined major must develop a proposal which outlines an intellectually coherent area of study (with degree title) and a plan of study (courses to be taken, pedagogical rationale, proposed schedule). The proposal should include an explanation of why it is not appropriate or possible to pursue such a program through the curriculum of any one of the colleges. It should outline a program of study for both general education (for example, the core requirements of one of the most relevant colleges or equivalent general education plan) and major requirements. The proposal should designate one of the participating colleges as the “home college” for tracking and verification purposes.

• The student’s proposal must be approved by a faculty advisor within a college who takes pedagogical responsibility for the program, by the dean of the college (or its equivalent at the college level), and by any other colleges involved in granting the degree. The signed proposal will be submitted to the Provost’s office for a final review and approval.

• Once approved by the dean and Provost’s office, the student’s major will be administered by the advisor and his/her progress tracked by the Dean’s office of the “home college.” The “home college” will be responsible for monitoring the student’s progress and reminding any collateral colleges of the approval of the student-defined major so that these colleges may insure the student’s ability to enroll in the necessary courses. Upon successful completion of the course
of study, the "home college" will be responsible for contacting all the relevant colleges and verifying the completion of the degree. Unless there are sufficient numbers of university student-defined majors in any graduation year, upon consultation with the "home college," students may choose to receive the diploma in the most relevant department's ceremony.

University Summer Sessions

The campus is in full operation during the summer, populated by students and faculty from a variety of programs. The university continues to have outstanding, innovative educational programs extending beyond regular involvement with its degree candidates. Three sessions of summer school are held for college students who wish to make up or advance their degree program studies. Every service and support organization is available to summer students: Computing Services, the Student Health Center, the Counseling Center, the University Libraries, the Office of Admission, the Career Center, Student Activities, etc.

**Session One:** mid-May to early July

**Session All:** mid-May to mid-August

**Session Two:** early July to mid-August

The three summer sessions of credit course work are designed to meet the needs of currently enrolled college students (not exclusively Carnegie Mellon students) as they complement or supplement various college programs. The university offers a wide range of courses in the Carnegie Institute of Technology (CIT), College of Fine Arts (CFA), College of Humanities and Social Sciences (H&SS), the Mellon College of Science (MCS), the School of Computer Science (SCS), and the Undergraduate Business Program in the Tepper School of Business.

Undergraduates have the opportunity to earn advanced credit, remove deficiencies, and regularize their schedules pursued during the academic year; graduates may work toward master's and doctor's degrees, and professional people are encouraged to increase their knowledge and skills. There are two summer sessions, both seven weeks in duration. Special programs and graduate work may cover other periods of time.

Carnegie Mellon reserves the right to withdraw any course not justified by the number of applicants and to make changes in scheduling when necessary and advisable.

Requests for further information should be addressed to:

The HUB
Enrollment Services
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
(412) 268-8186
FAX: (412) 268-8084
Department of Athletics and Physical Education

Susan Bassett, Director of Athletics
Office: 204 Gymnasium
http://www.cmu.edu/athletics/physed/

Intercollegiate Athletics

Carnegie Mellon emphasizes excellence in its intercollegiate athletic programs as well as in its classrooms. The University strongly believes that academic and athletic excellence can successfully coexist. It also believes that intercollegiate athletics are important in student life and can become a key part of the educational experience. Professional and social endeavors after graduation also benefit from university experiences as a student-athlete.

Carnegie Mellon sports teams have competed intercollegiately since the early 1900s. In the past 15 years, the program has experienced extensive success. The Tartans have won 81 conference championships and competed in over 108 national championships since 1976. This success has been achieved while meeting all of the academic requirements of demanding programs and without athletic scholarships.

In 1986, Carnegie Mellon became a charter member of the University Athletic Association (UAA), a nine-team league of similar institutions with regard to academic and athletic programs. The UAA, a national association which geographically reaches as far north as Massachusetts, as far south as Atlanta and as far west as St. Louis and Chicago, sponsors intercollegiate competition in 24 sports including 12 for men and 12 for women. UAA members include Brandeis University, Case Western Reserve University, Carnegie Mellon University, Emory University, New York University, the University of Chicago, the University of Rochester and Washington University in St. Louis.

Carnegie Mellon, like the other seven UAA members, is a member of the National Collegiate Athletic Association (NCAA). Its intercollegiate teams compete on the Division III level, which prohibits athletic scholarships and operates under the true meaning of amateurism. Student-athletes who play at the varsity level are students first and athletes second. All students, both athletes and non-athletes, are treated equally with regard to admission and financial aid policies. Carnegie Mellon fully supports a policy of equity in resources and opportunities for women and men.

The university fields competitive teams in 17 sports. The Tartans compete in football, men’s and women’s soccer, men’s and women’s cross-country, men’s and women’s tennis, women’s volleyball, men’s and women’s basketball, men’s and women’s swimming, men’s and women’s indoor and outdoor track and field, and golf.

Carnegie Mellon’s intercollegiate program has consistently produced winners. The Tartans’ football team has won 15 conference championships, has a string of 33 consecutive winning seasons, and has appeared in the NCAA Division III Championship playoffs six times. In 1979, Carnegie Mellon was awarded the Lambert Trophy as the best small college team in the northeast. The men’s cross country won the conference championship in 2005 going on and placing 8th at nationals that same season. The team also has had a 12th and 9th place finish at nationals. The women’s cross country won the 1998 conference and went on to place 4th nationally.

A freshman computer science major on the men’s tennis team won the NCAA National singles title in 2000 and Carnegie Mellon’s top doubles team also was selected to play in the nationals. The men’s program garnered their highest team ranking ever in 2006 at 11th nationally. The women’s tennis team has recently produced national ranked players in the NCAA competition and in 2005 had a sophomore claim the ITA National Small College Championship while earning the James O’Hara Sargent Sportsmanship Award. Both men’s and women’s swimming and track and field teams annually qualify a number of athletes for the national championships. Swimming recently has produced a national champion and the men’s track and field team has won back-to-back conference championships.

To provide excellence in the athletic program, the department employs full-time coaches in all varsity sports. Intercollegiate competition begins with the first football and soccer games in early September and ends with the UAA track and field, golf and tennis championships in late April. Students with athletic skills in any of the above mentioned sports are welcome to become members of the team. Participation is open to all students. Inquiries may be directed to the appropriate coach at the:

Recreation

In addition to providing for its more formal programs and teams, Carnegie Mellon’s athletic facilities are available for use by individual students on an extensive seven-day per week schedule.

The Skibo Gymnasium, has facilities for basketball, volleyball, badminton, weight lifting, and cardio equipment. Located within the University Center are facilities for squash, basketball, racquetball, volleyball, badminton, a diving pool and a large swimming pool for lap swim, cardio machines like treadmills, Expresso Bike EFX, steppers, Cybex machines, dumbbells, a sauna and a whirlpool. Gestling Stadium provides soccer, football and track facilities. Tennis courts, located between the University Center and Margaret Morrison, are lighted for night play. During the school year they are open for use by students, faculty and staff.

These facilities are available to any student, faculty or staff person with a valid Carnegie Mellon ID. For hours, please contact the Athletic Office at (412) 268-1236, or visit our website.

Physical Education

The Department of Physical Education provides an elective program with an emphasis on personal fitness and lifetime recreation, thus preparing students for physical activity after the college years. Most classes are offered on a mini-course system with each class running seven weeks in length.

This program of more than 30 courses is designed for all students, from the beginner to those students who have already developed some skill. Courses include personal fitness, racquetball, tennis, golf, weight training, karate, aerobic fitness, and yoga. Instruction is also provided in several team sports. Carnegie Mellon also provides courses for American Red Cross certification in the four levels of swimming (beginners, intermediate, swimmers, and life guarding), and First Aid and Cardiopulmonary Resuscitation (CPR).

Intramural Sports

For those who seek another level of competition or just like to participate and have fun, the Intramural Program provides recreation and relaxation for all students, faculty and staff, regardless of the degree of their natural athletic skills. The university prides itself on an intramural program which annually involves 6,000 students. Men and women, both graduate and undergraduate, compete in more than 20 different activities. Major sports include flag football, soccer, volleyball, floor hockey, basketball, and softball. A few of our popular tournaments are ultimate frisbee, dodgeball, tennis, and badminton.

Through participation in this program, students are able to keep physically fit, put to good use various learned skills, and develop leadership, team play and sportsmanship. Intramural activities, like all sports endeavors, contribute to physical development, good health, and a sound state of mind, while providing keen competition and team spirit. In addition, intramurals possess an inherent flexibility that allows for a limited commitment of time in light of academic priorities. The intramural program permits students from all departments to meet and socialize on an informal basis.

Fitness and Wellness

The university is well aware that fitness is a vital contributor to an individual’s well-being and productivity. For this reason the department is committed to providing the entire campus community with the opportunity and resources to keep fit for the new century.

The Fitness and Wellness program provides educational services, programs, workshops and seminars. Programs include cardio-respiratory fitness, muscular strength, blood pressure and stress reduction. Workshops include the topics of nutrition, weight control, stress management and lower back care and prevention. The Group X program provides over 30 exercise classes per week ranging from yoga and pilates to zumba and spinning.

Faculty

SHANNON AGNEW, Assistant Women’s Soccer Coach – Bachelor of Arts, University of Tampa; Carnegie Mellon, 2012–.
SUSAN BASSETT, Director of Athletics – M.S., Indiana University, Carnegie Mellon, 2005–.

GARY ALDRICH, Associate Head Track & Field Coach/Instructor – M.S., Slippery Rock University, Carnegie Mellon, 2006–.

MICHAEL BELMONTE, Assistant Men/Women Tennis – History, Duquesne; Carnegie Mellon, 2010–.

TERRY BODNAR, Assistant Football Coach/Instructor – M.S., Indiana University of PA, Carnegie Mellon, 1984–.

JOSH CENTOR, Assistant Director of Athletics – B.A., Brandeis University, Carnegie Mellon, 2008–.


ANDREW GARCIA, Assistant Men’s Basketball Coach – History, Tulane University; Carnegie Mellon, 2011–.

SARA GAUNTNER, Assistant Director of Athletics for Instructional Programs & Recreation & Aquatics Director/Instructor – M.S., Duquesne University, Carnegie Mellon, 2005–.

ANDREW GIRARD, Head Men’s and Women’s Tennis Coach/Instructor – B.S., Michigan Tech University, Carnegie Mellon, 2003–.

SARAH HAYES, Assistant Women’s Basketball Coach, Carnegie Mellon, 2011–.

JACQUIE HULLAH, Head Women’s Basketball Coach, Carnegie Mellon, 2011–.

KIM KELLY, Head Women’s Volleyball Coach/Instructor – MBA, Mt. St. Mary’s University, Carnegie Mellon, 2005–.

MATTHEW KINNEY, Head Swimming and Diving Coach/Instructor – M.S., Western Illinois, Carnegie Mellon, 2007–.


ARRON LUJAN, Head Men’s Soccer Coach – M.S., Virginia Commonwealth University, Carnegie Mellon, 2008–.

DONNA MOROSKY, Director of Fitness and Health/Instructor – Post-Graduate Education, University of Pittsburgh; Carnegie Mellon, 1975–.

MICHAEL PIRANIAN, Assistant Men’s Soccer Coach/Instructor – B.S., Virginia Polytechnic Institute & State University, Carnegie Mellon, 2008–.

JEFF SIMMONS, Assistant Football Coach/Instructor – B.A., Geneva College; Carnegie Mellon, 2010–.

PATTYE STRAGAR, Operations Manager for Fitness and Aquatics/Instructor – B.S., Northwestern University; Carnegie Mellon, 2003–.

YON STRUBLE, Head Men’s Soccer Coach/Instructor – M.S., Georgia State; Carnegie Mellon, 2010–.

TONY WINGEN, Head Men’s Basketball Coach/Associate Athletic Director/Instructor – M.Ed., Springfield College; Carnegie Mellon, 1990–.
Reserve Officers Training Corps (ROTC)

Department of Aerospace Studies (Air Force ROTC)

Mark T. McKenzie, Colonel, U.S. Air Force
Office: 2917 Cathedral of Learning, University of Pittsburgh

In the four-year commissioning program, a student takes the general military course (GMC) during the freshman and sophomore years, attends a four-week summer training program, and then takes the professional officer course (POC) in the junior and senior years. In the two-year commissioning program, a student attends a five-week summer training program following his or her junior year and then enters the POC. A student is under no contractual obligation to the Air Force until entering the POC or accepting an Air Force scholarship. In addition to the academic portion of the curriculum, each student attends two hours of leadership lab each week. This lab utilizes a student organization designed for the practice of leadership and management techniques. Two to three scholarships and a half-year scholarships are available on a competitive basis to qualified students. Many AFROTC scholarships cover a portion of tuition costs, incendentals and lab fees, $600 for books, plus pay each recipient $250-$400 per month.

General Military Course (GMC)

The subject matter for the freshman and sophomore years is developed from an historical perspective and focuses on the scope, structure, and history of military power with emphasis on the development of air power. The freshman courses explore the role of U.S. military forces, and the Air Force in particular, through a study of the total force structure, strategic offensive and defensive forces, general-purpose forces, and support forces. The sophomore courses include an introduction to the history of air power with emphasis on the development of concepts and doctrine governing the employment of U.S. air power.

Professional Officer Course (POC)

The Professional Officer Course, taken during the cadet’s junior and senior years, concentrates on three main themes: the concepts and practices of management, leadership, and national defense policy. During the first term of the junior year, the course concentrates on a study of the management functions: planning, organizing, coordinating, directing, and controlling. Basic and advanced management techniques, as found in the military and industrial environment, are explored. The second term deals with the application of general concepts of leadership to Air Force situations. As a basic study of human behavior, human relationships, and professional ethics, the course emphasizes the similarities between the problems encountered in the military and civilian environment. The first term of the senior course concentrates on selected elements of the U.S. government and national security process engaged in producing national strategy as well as various elements of U.S. military forces, doctrine, and employment capabilities. During the second term, the course concentrates on the strategic options available to the U.S. and on the manner in which policy choices are made. The course also includes a review of the military justice system.

For details about the two programs as well as information on the courses, scholarships and flying programs, interested students are encouraged to contact the Air Force ROTC detachment, or write to the Professor of Aerospace Studies, Air Force ROTC, 2917 Cathedral of Learning, University of Pittsburgh, Pittsburgh, PA 15260.

Department of Military Science (Army ROTC)

John N. Bender, Lieutenant Colonel, U.S. Army
Office: Bellefield Hall, Room 409, University of Pittsburgh

The Army Reserve Officers’ Training Corps (ROTC) program support-ing Carnegie Mellon University is located at the University of Pittsburgh. It exists to train the future officer leadership of the United States Army and offers opportunities and challenges that can put college students on the fast track to success in life. ROTC provides a combination of academics and important hands-on training, in addition to physical and mental challenges that will help students succeed in college and beyond. Through the training in ROTC, students will develop the confidence, self-esteem, motivation and leadership skills they will need regardless of their career plans.

The Four-Year Program

The traditional Four-Year program is divided into two parts. The Basic Course is taken in the freshman and sophomore years. There is no commitment for non-scholarship students at this level. Upon successful completion of the Basic Course, students are eligible for the Advanced Course, taken in the junior and senior years. At the beginning of the Advanced Course, students will decide whether or not they wish to become officers in the Army and enter into a formal contract. During the summer between the junior and senior years, students are required to attend the the Leader Development and Assessment Course (LDAC). Upon successful completion of a University degree and the Army ROTC program, students are commissioned into the United States Army as a Second Lieutenant.

The Two-Year Program

If the first two years of ROTC are not taken, students can attend the Leader’s Training Course (LTC) during the summer between the sophomore and junior year. This camp will qualify students to begin the Advanced Course in their junior year or in the first year of a two-year graduate program. Or, if students have served in the active duty military, attended a military academy for one year, participated in ROTC for three years or belong to a Army National Guard or Army Reserve unit, they already qualify for entrance into the Advanced Course.

The Alternative Entry Program

The Alternative Entry Program is designed for academic junior students with no prior qualifying military training but are otherwise qualified. This option allows students to contract into the Advanced Course without receiving placement credit for the basic course. Students accepted into this program must complete the Leader’s Training Course and the Leader Development and Assessment Course during the summer months.

Curriculum

<table>
<thead>
<tr>
<th>Year</th>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>Introduction to Military Leadership</td>
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<tr>
<td></td>
<td>Foundations of Leadership</td>
<td>5</td>
</tr>
<tr>
<td>Sophomore</td>
<td>Leadership Dynamics and Application</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Applications in Leadership and Combat</td>
<td>5</td>
</tr>
<tr>
<td>Junior</td>
<td>Basic Leader Planning and Combat</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Advanced Leader Planning and Combat</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Leadership Development Assessment</td>
<td>5</td>
</tr>
<tr>
<td>Senior</td>
<td>Progressive Leadership Theory and</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Transition to the Profession of Arms</td>
<td>5</td>
</tr>
</tbody>
</table>

Army ROTC Scholarships

Army ROTC offers four, three and two year full scholarships with additional annual allowances of $900 for books and a monthly stipend. High school, undergraduate and incoming two-year graduate students are eligible to apply. For application and information call ROTC at the University of Pittsburgh at (412) 624-6254/6197.

The Simultaneous Membership Program (SMP)

This program allows students to become members of the Army National Guard or the Army Reserves while enrolled in Army ROTC. Students in the Advanced Course who are SMP are paid for their Guard/Reserve training. The benefit of this program is that students in the Advanced Course are able to act as Army officers in their National Guard or Reserve unit, receiving valuable leadership experience.

Summer Programs

Leadership Development & Assessment Course

This 35-day camp is a requirement for all contracted students. Students attend the summer between their junior and senior year. Students are placed in various leadership positions throughout Camp and their skills and abilities will be tested and evaluated in preparation of a commission in the United States Army. All expenses are paid by the Army. Students are paid while attending.

Leader’s Training Course

This 35-day camp is taken as a prerequisite for entry into the Ad-vanced Course if the Basic Course cannot be fulfilled. It is taken the summer before the sophomore year. All expenses are paid by the Army. Students are paid while attending.

Army Adventure Training

ROTC students may participate in Airborne School, Air Assault School, Northern Warfare School and Mountain Warfare School the summer before the sophomore and junior year. These courses range from two to four weeks and students must arrive in top physical condition. All expenses are paid by the Army.
Extracurricular Activities

Rangers
Army ROTC students are eligible to participate in the Cadet Ranger Club. The club conducts physically and mentally challenging extracurricular training to promote fitness, teamwork, self-confidence and fellowship. Training includes physical fitness, rappelling, rope bridging, tactics, hiking, climbing, weapons training and orienteering.

Scabbard & Blade
National Honor Society consisting of cadets/midshipmen from Army, Air Force and Naval ROTC.

Rho Tau Chi
Military fraternity established for the members of the various branches of ROTC. Purpose is to draw together cadets to increase communication and feelings of goodwill between the Cadet Corps and the community. Cadets participate in a variety of community service projects.

Color Guard
Dedicated group of Army ROTC cadets who train and perform to present the American flag and Army colors at football and basketball games and various community events.

Department of Naval Science (Naval ROTC)
Gregory Billy, Captain, U.S. Navy
Office: 4615 Forbes Avenue

The Department of Naval Science was established 16 December 1987. Its mission is to prepare young men and women mentally, morally, and physically, and to instill in them the highest qualities of duty, honor, and loyalty, in preparation for leadership positions in the naval service.

Carnegie Mellon’s Naval Reserve Officers’ Training Corps (NROTC) is designed for young men and women who are seeking a challenging academic experience and who desire to serve their country as officers in the Navy or Marine Corps after graduation.

Midshipmen wear civilian clothes to classes but wear uniforms one day of the week. NROTC students are active in all facets of university life; many are in positions of leadership in student government, on varsity and intramural sports teams, in campus clubs, and other student organizations. The NROTC program seeks students who are bright, ambitious, enthusiastic leaders whose lives are enriched by their education at Carnegie Mellon and by their involvement in NROTC.

Four-Year Scholarship Program

The four-year scholarship program provides full tuition and university fees, $750 for textbooks per year, uniforms, and a $250 per month tax-free subsistence allowance to students during their freshman year. This stipend then increases to $300 during their sophomore year, $350 for their junior year and $400 for their senior year. Midshipmen must complete a university-approved curriculum of their choice, including courses in calculus and calculus-based physics (Navy Option Only), and specified courses in naval science subjects. Paid summer training periods are also provided.

Scholarships are awarded on the basis of a nationwide competition before the start of the freshman year. Midshipmen commissioned through the scholarship programs become officers in the Navy or Marine Corps and incur a four-year active duty obligation in a selected area of the naval service.

Tweedale Scholarship Program

This scholarship program provides the same benefits as the four-year program, but is targeted toward currently enrolled students who have completed at least one, but not more than four semesters, and who are pursuing technical majors. This program allows a highly-qualified engineering, physics, chemistry, or mathematics student who has never attended a NROTCC scholarship program in the past to be considered for this scholarship. Solid academic standing within his or her field of study is required, including a ranking within the top half of students pursuing his or her chosen course of study. If nominated by the Professor of Naval Science for this scholarship, the student will generally receive a scholarship decision within 5 working days from submission. Midshipmen commissioned through the scholarship programs become officers in the Navy or Marine Corps Reserve upon graduation. The active duty obligation for this program is three years. Students receive all naval science textbooks and uniforms. Additionally, if awarded advanced standing during their junior and senior years, they receive a tax-free subsistence monthly allowance of $350 and $400 respectively. A paid summer training period is provided between the junior and senior year. College program students may compete for three- and two-year scholarships described in the following paragraph.

College Program Three- and Two-Year Scholarships

Three-year scholarships are available on a competitive basis to those qualifying college program (non-scholarship) NROTC students who have demonstrated leadership and academic excellence during their freshman or sophomore year and are nominated for the scholarship by the Professor of Naval Science. Scholarship benefits are identical to those provided by the four-year scholarship program. Active duty obligation is four years upon commissioning in a selected area of the naval service.

Two-Year National Scholarship Program

Sophomores who have not participated in the NROTC program may apply for a nationally competitive two-year NROTC scholarship. The two-year scholarship program provides the same benefits as the four-year program for a period of 20 months. Students must apply for this program no later than February of their sophomore year. Students selected for this program attend the Naval Science Institute during the summer before their junior year to complete required naval science course material. A paid summer training period is provided between the junior and senior years. Commissionees incur a four-year active duty obligation upon graduation in a selected area of the naval service.

Curriculum

The sequence of naval science courses is the same for all officer candidates for the first three semesters. Midshipmen accepted into the Marine Corps option program will have curriculum variations starting with their third year. Additionally, some candidates may be required to complete courses in American military affairs, national security policy, English, mathematics, and/or the physical sciences. Descriptions of the course requirements for each candidate classification (scholarship/college program) may be obtained from the Department of Naval Science office.

All scholarship and college program students are required to attend a weekly 1.5 hour Naval Laboratory (32-100) where professional orientation, military drill, physical fitness, and leadership are emphasized. Guest speakers from the Fleet are frequent participants in these laboratories. Naval Science courses are open to all students. Since these are required courses for NROTC students, they will be given priority in enrollment.

Remaining spaces will be filled through the normal university registration process.

<table>
<thead>
<tr>
<th>Naval Professional Academic Courses</th>
<th>(Navy Science Courses)</th>
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</thead>
<tbody>
<tr>
<td>Freshman Year</td>
<td>Units</td>
</tr>
<tr>
<td>32-100 Naval Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>32-101 Introduction to Naval Science</td>
<td>6</td>
</tr>
<tr>
<td>32-102 Seapower and Maritime Affairs</td>
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</table>

<table>
<thead>
<tr>
<th>Sophomore Year</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>32-200 Naval Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>32-201 Leadership &amp; Management</td>
<td>9</td>
</tr>
<tr>
<td>32-212 Navigation *</td>
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<table>
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<tr>
<th>Junior Year</th>
<th>Units</th>
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<tbody>
<tr>
<td>32-300 Naval Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>32-310 Evolution Of Warfare</td>
<td>9</td>
</tr>
<tr>
<td>32-311 Naval Ship Systems I Engineering</td>
<td>*</td>
</tr>
<tr>
<td>32-312 Naval Ship Systems I Weapons</td>
<td>9</td>
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<tr>
<th>Senior Year</th>
<th>Units</th>
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<tr>
<td>32-400 Naval Laboratory</td>
<td>3</td>
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<tr>
<td>32-402 Leadership and Ethics</td>
<td>6</td>
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<tr>
<td>32-410 Amphibious Warfare</td>
<td>9</td>
</tr>
<tr>
<td>32-411 Naval Operations and Seamanship</td>
<td>*</td>
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</tbody>
</table>

Footnotes:
* Required of students in the Navy Option
** Required of students in the Marine Option

All courses are required of all students in the program.

Army ROTC Faculty

JOHN N. BENDER, Lieutenant Colonel, Professor of Military Science – M.S., Long Island University; Carnegie Mellon, 2004–.

ANDREW R. KICK, Captain, Assistant Professor of Military Science – B.S., University of Dayton; Carnegie Mellon, 2005–.

ROY C. NICKERSON, Captain, Assistant Professor of Military Science – B.A., Western Kentucky University; Carnegie Mellon, 2004–.
Naval ROTC Faculty

GREGORY BILLY, Captain, US Navy; Professor of Naval Science – B.S., United States Naval Academy; Carnegie Mellon, 2008–.

JOSEPH GRANT, Lieutenant Colonel, U.S. Marine Corps; Associate Professor of Naval Science – M.A., Naval Postgraduate School; Carnegie Mellon, 2008–.

ALEX LEARY, Lieutenant, U.S. Navy; Assistant Professor of Naval Science – M.S., University of Pittsburgh; Carnegie Mellon, 2008–.

BRIAN PATTERSON, Lieutenant, U.S. Navy; Assistant Professor of Naval Science – B.S., United States Merchant Marine Academy; Carnegie Mellon, 2007–.

JOSEPH THOMPSON, Lieutenant; U.S. Navy; Assistant Professor of Naval Science – B.S., United States Naval Academy; Carnegie Mellon, 2006–.
Intercollege Programs

Intercollege Programs .................................................  62
BXA Intercollege Degree Programs .............................. 70
Bachelor of Science in Computational Biology ............ 62
Bachelor of Science in Computational Finance .............. 62
Minor in Computational Finance ................................. 64
Minor in Health Care Policy and Management .............. 64
Additional Major in Human-Computer Interaction ....... 65
B.S. in Mathematical and Statistical Sciences ............... 66
Bachelor of Science in Music and Technology .......... 66
Major in Psychology & Biological Sciences ................. 67
Science and Humanities Scholars Program ................. 68
### Intercollege Programs

Carnegie Mellon University offers several degree programs and courses of study which are coordinated by multiple colleges, reflecting the interdisciplinary nature of the university. These are detailed below.

#### BXA Intercollege Degree Programs

The BXA Intercollege Degree Programs enable students the freedom to individualize their educational experience by promoting integration, balance and innovation. There are three degree programs from which to choose:

- Bachelor of Humanities and Arts
- Bachelor of Science and Arts
- Bachelor of Computer Science and Arts

For detailed information on the BXA Intercollege Degree Programs, go to [http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/bxaintercollege/](http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/bxaintercollege/).

### Bachelor of Science in Computational Biology

Computational Biology is concerned with solving biological and biomedical problems using mathematical and computational methods. It is recognized as an essential element in modern biological and biomedical research. There have been fundamental changes in biology and medicine over the past decade due to spectacular advances in biomedical imaging, genomics, and proteomics. The nature of these changes demands the application of novel theories and advanced computational tools to decipher the implications of these data, and to devise methods of controlling or modifying biological function. Consequently, Computational Biologists must be well trained and grounded in biology, mathematics, and computer science.

The School of Computer Science and Mellon College of Science have joined forces to establish an exciting interdisciplinary program leading to a B.S. in Computational Biology. The goal of this degree program is to provide an intensive interdisciplinary education to enable outstanding students to become leaders in identifying and solving tomorrow’s biological problems using computational methods. The program’s curriculum is truly interdisciplinary and is designed for students interested in the intersection of Biology and Computer Science.

Applications to the program are invited from current sophomores. Applicants must have completed, or be currently enrolled in: and . Applicants must submit an informal transcript (whiteprint, obtainable from their academic advisor) and an essay describing their interest in the program. Completed applications should be submitted to Dr. Maggie Braun at mabraun@andrew.cmu.edu in Doherty Hall 1320, Dr. Karen Thickman at kthickman@cmu.edu in Gates-Hillman Center 7403, or Dr. Tom Cortina at tctorina@cs.cmu.edu in Gates-Hillman Center 4117 no later than one week after midterm grades are released in a given semester.

### Degree Requirements

- **Math/Stats Core**
  - 21-120 Differential and Integral Calculus
  - 21-122 Integration, Differential Equations and Approximation
  - 21-127 Concepts of Mathematics
  - 21-xxx Math Elective (21-241, 21-260, 21-341)
  - 36-xxx Statistics Elective (36-217, 36-225, 36-247, 36-625)
  - **47 units**

- **General Science Core**
  - 09-105 Introduction to Modern Chemistry I
  - 09-106 Modern Chemistry II
  - 09-217 Organic Chemistry I
  - 33-111 Physics for Science Students
  - **41 units**

- **Biological Sciences Core**
  - 03-121 Modern Biology
  - 03-231 Biochemistry I
  - 03-232 Biochemistry II
  - 03-240 Cell Biology
  - 03-330 Genetics
  - 03-342 Introduction to Biological Laboratory Practices
  - 03-343 Experimental Techniques in Molecular Biology
  - 03-101 Undergraduate Colloquium for Sophomores
  - 15-128 Freshman Immigration Course
  - 03-411 Topics in Research
  - **51 units**

- **Computer Science Core**
  - 15-122 Principles of Imperative Computation
  - 15-150 Principles of Functional Programming
  - 15-210 Parallel and Sequential Data Structures and Algorithms
  - 15-251 Great Theoretical Ideas in Computer Science
  - 14-451 Algorithm Design and Analysis
  - **56 units**

### General Education

- **75 units**
  - 03-311 Computational Molecular Biology and Genomics
  - 03-xxx, 05-xxx, or 02-xxx Computational Biology Electives
  - 03-3xx Advanced Biology Elective
  - 15-xxx Advanced Computer Science Elective (15-211 or higher)

### Free Electives

- **40-49 units**

### Minimum number of units required for degree:

- **360 units**

### Bachelor of Science in Computational Finance

The Mellon College of Science, the Heinz College of Public Policy and Management, and the Tepper School of Business jointly offer a degree uniquely designed to meet the quantitative needs of the finance industry. Modeled after the highly successful Carnegie Mellon Master of Science in Computational Finance, this degree allows students to develop a deep knowledge of mathematics, probability, statistics, and the applications of these disciplines to finance. Students who complete this degree may directly enter the finance industry, enter other industries where an applied mathematics training is appropriate, or pursue advanced degrees in economics, finance or the mathematical sciences. Students entering the work force upon completion of this degree may wish to later complement their undergraduate degree with a Master’s degree in Business Administration or other professional degree. Students who might eventually pursue doctoral degrees in economics, finance, statistics or mathematics should seek advising on how to use their electives in order to prepare for graduate work in their chosen disciplines. Students apply for admission to the B.S. program in Computational Finance in the second semester of the sophomore year. Later application is also possible.

The Bachelor of Science in Computational Finance is an Intercollegiate Program. Students who pursue Computational Finance as their primary major may elect to have either the Mellon College of Science (MCS) or the Tepper School of Business (Tepper) as their home college. The coursework required for the major is the same in either case, with one minor exception outlined below. The general education requirements for the degree depend on the student’s home college. MCS students must complete the same Humanities, Social Sciences, and Fine Arts requirements as other MCS students. In addition, MCS students are required to take two science courses, one fewer than other MCS majors. Tepper students must complete the Breadth Requirements of the Undergraduate Business Administration Program. Additionally, they must take several courses from the Functional Business Core of that program.

Majors in Computational Finance can tailor their degree program by selecting Depth Electives aligned with their interests and ambitions. MCS students are required to take three depth electives. Tepper students must take two depth electives and 70-391 Finance (MCS students may select 70-391 as one of their four depth electives).

### MCS Science Requirements

Students intending to apply to the B.S. program in Computational Finance should take two semesters of calculus, 21-120 Differential and Integral Calculus and 21-122 Integration, Differential Equations and Approximation, and 15-110 Principles of Computing.

### Computer Science Core

- 15-122 Principles of Imperative Computation
- 15-150 Principles of Functional Programming
- 15-210 Parallel and Sequential Data Structures and Algorithms
- 15-251 Great Theoretical Ideas in Computer Science
- 14-451 Algorithm Design and Analysis
- **56 units**

### Major Electives

- 03-311 Computational Molecular Biology and Genomics
- 03-xxx, 05-xxx, or 02-xxx Computational Biology Electives
- 03-3xx Advanced Biology Elective
- 15-xxx Advanced Computer Science Elective (15-211 or higher)
- **45-54 units**

### General Education

- 09-105x Computing @ Carnegie Mellon
- 76-101 Interpretation and Argument
- 9 Elective Cognition, Choice and Behavior
- 9 Elective Economics, Political and Social Institutions
- 9 Elective Cultural Analysis
- 9 Non-technical Elective
- 9 Non-technical Elective
- 9 Non-technical Elective
- 9 Free Electives
- **40-49 units**

### Minimum number of units required for degree:

- **360 units**

* these two courses are co-requisites and must be taken together.
MCS Humanities, Social Sciences & Fine Arts Requirements

Candidates for the B.S. in Computational Finance must complete 72 units offered by the College of Humanities and Social Science and/or the College of Fine Arts. Of these 72 units, 36 are specified by the detailed curriculum in below. These are:

- 76-101 Interpretation and Argument 9
- 73-100 Principles of Economics 9
- 73-230 Intermediate Microeconomics 9
- 73-240 Intermediate Macroeconomics 9

Two of the remaining four courses must be in specific categories as listed in the section on general requirements for a Bachelor’s degree in the Mellon College of Science. One in Category 1: Cognition, Choice and Behavior, and one in Category 3: Cultural Analysis.

Tepper Functional Business Core

The Functional Business Core of the Undergraduate Business Administration Program includes 70-122 Introduction to Accounting, which is required by all Computational Finance majors. It also includes 70-391, which Tepper students majoring in Computational Finance must take in place of one Depth Elective. In addition, Tepper students pursuing the B.S. in Computational Finance must complete six other courses from the Functional Business Core.

These courses are:
- 70-100 Global Business 9
- 70-311 Organizational Behavior 9
- 70-332 Business, Society and Ethics 9
- 70-371 Production/Operations Management 9
- 70-381 Marketing 9
- 70-401 Management Game 12

Tepper Breadth Requirements

Candidates for the B.S. in Computational Finance must complete the breadth requirements outlined in the section describing the Undergraduate Business Administration Program.

Depth Electives

The detailed curricula below include three or four depth electives. These may be chosen from among the following:

- 21-355 Principles of Real Analysis I 9
- 21-365 Projects in Applied Mathematics 9
- 21-372 Partial Differential Equations 9
- 36-401 Modern Regression 9
- 36-402 Advanced Data Analysis 9
- 38-461 Special Topics: Epidemiology 9
- 70-391 Finance 9
- 70-398 International Finance 9
- 70-392 Investment Analysis 9
- 70-495 Corporate Finance 9
- 70-497 Derivative Securities 9
- 73-252 Advanced Microeconomic Theory 6
- 73-253 Advanced Macroeconomic Theory 6
- 73-372 International Money and Finance 9
- 73-392 Financial Economics 9
- 73-420 Monetary Theory and Policy 9

MCS Detailed Curriculum

What follows is the detailed curriculum for the Bachelor of Science in Computational Finance in the Mellon College of Science. The courses listed are required. The seminars in which the courses are to be taken are suggested.

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>70-100</td>
<td>Global Business</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Science Requirement</td>
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<td>41-44</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
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<tr>
<td>70-122</td>
<td>Introduction to Accounting</td>
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<tr>
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Sophomore Year

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<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
</tr>
<tr>
<td>or 21-242</td>
<td>Matrix Theory</td>
</tr>
<tr>
<td>or 21-341</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities, Social Science or Fine Arts Elective</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
</tr>
<tr>
<td>21-270</td>
<td>Introduction to Mathematical Finance</td>
</tr>
<tr>
<td>21-369</td>
<td>Numerical Methods</td>
</tr>
<tr>
<td>73-230</td>
<td>Intermediate Microeconomics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
</tr>
<tr>
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Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
</tr>
<tr>
<td>21-325</td>
<td>Probability</td>
</tr>
<tr>
<td>21-370</td>
<td>Discrete Time Finance</td>
</tr>
<tr>
<td>73-240</td>
<td>Intermediate Macroeconomics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
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<tr>
<th>Spring</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-420</td>
<td>Continuous-Time Finance</td>
</tr>
<tr>
<td>36-226</td>
<td>Introduction to Statistical Inference</td>
</tr>
<tr>
<td>36-410</td>
<td>Introduction to Probability Modeling</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities, Social Science or Fine Arts Elective</td>
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<tr>
<td>xx-xxx</td>
<td>Depth Elective</td>
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Senior Year

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<th>Fall</th>
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<tbody>
<tr>
<td>45-816</td>
<td>Studies in Financial Engineering</td>
</tr>
<tr>
<td>90-718</td>
<td>Strategic Presentation Skills</td>
</tr>
<tr>
<td>94-700</td>
<td>Organizational Design &amp; Implementation</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Depth Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities, Social Science or Fine Arts Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
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<thead>
<tr>
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<tbody>
<tr>
<td>94-701</td>
<td>Business English</td>
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<td>xx-xxx</td>
<td>Depth Elective</td>
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<tr>
<td>xx-xxx</td>
<td>Humanities, Social Science or Fine Arts Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
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</table>

Tepper Detailed Curriculum

What follows is the detailed curriculum for the Bachelor of Science in Computational Finance in the Tepper School of Business. The courses listed are required. The semesters in which the courses are to be taken are suggested.

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>or 21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>70-100</td>
<td>Global Business</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>76-100</td>
<td>Interpretation and Argument</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Science Requirement</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
</tr>
<tr>
<td>73-230</td>
<td>Intermediate Microeconomics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Breadth Course</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Breadth Course</td>
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</table>
## Intercollege Programs

### Sophomore Year

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<tr>
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<th>Units</th>
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</thead>
<tbody>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>21-325 Probability</td>
<td>9</td>
</tr>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-270 Introduction to Mathematical Finance</td>
<td>9</td>
</tr>
<tr>
<td>36-226 Introduction to Statistical Inference</td>
<td>9</td>
</tr>
<tr>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-381 Marketing I</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

### Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>21-370 Discrete Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Breadth Course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Elective</td>
<td>9</td>
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<tr>
<td><strong>Total</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-369 Numerical Methods</td>
<td>9</td>
</tr>
<tr>
<td>21-420 Continuous-Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>36-410 Introduction to Probability Modeling</td>
<td>9</td>
</tr>
<tr>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Breadth Course</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</table>

### Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-816 Studies in Financial Engineering</td>
<td>6</td>
</tr>
<tr>
<td>70-332 Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>70-401 Management Game</td>
<td>12</td>
</tr>
<tr>
<td>xx-xx Breadth Course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Depth Elective</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-718 Strategic Presentation Skills</td>
<td>6</td>
</tr>
<tr>
<td>94-701 Business English</td>
<td>6</td>
</tr>
<tr>
<td>xx-xx Depth Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Breadth Course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xx Elective</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

### Minor in Computational Finance

Students do not need to apply for the minor in Computational Finance, however in order to declare the minor in Computational Finance, a student must satisfy one of the following two requirements:

1. Completion of 21-270 Introduction to Mathematical Finance with a grade of A and an overall QPA of at least 3.2.

2. Completion of 21-270 Introduction to Mathematical Finance and 21-370 Discrete Time Finance with an average grade of B and an overall QPA of at least 3.0.

When a student has met the necessary requirements, he or she may declare the minor by contacting the Associate Director of the Undergraduate Computational Finance program.

| 21-241 Matrices and Linear Transformations | 9-10  |
| 21-242 Matrix Theory                     |      |
| 21-341 Linear Algebra                    |      |
| 21-259 Calculus in Three Dimensions      |      |
| 21-256 Multivariate Analysis             |      |
| 21-260 Differential Equations            |      |
| 21-370 Introduction to Mathematical Finance | 9     |
| 21-370 Discrete Time Finance             | 9     |
| 21-420 Continuous-Time Finance           | **9**|

To avoid excessive double counting, Mathematical Sciences majors may not count 21-270 Introduction to Mathematical Finance, 21-370 Discrete Time Finance or 21-420 Continuous-Time Finance toward any other requirement.

*The re-requirements for 21-370 are 21-270 and either 21-256 or 21-259, and the co-requisite is 70-207, 21-325, 36-225 or 36-217. Note that 70-207 is not accepted as a prerequisite for 21-420.

** The pre-requisites for 21-420 are 21-260, 21-370 and one of the following three calculus based probability courses: 21-325, 36-225 or 36-217. Note that 70-207 is not a sufficient preparation in probability. Also note that 21-122 is a prerequisite for 21-260 and that 21-127 is a prerequisite for 21-341 and is recommended for 21-241.

Students minoring in Computational Finance are strongly encouraged to take one or two economics course, e.g., 73-100, 73-230, or 73-240.

### Minor in Health Care Policy and Management

**Sponsored by:**

- H. John Heinz III College
- Dietrich College of Humanities and Social Sciences
- Mellon College of Science

**Faculty Advisors:**

- Caroline Acker, Dietrich College of Humanities and Social Sciences
- Pati Lee, H. John Heinz III College
- Justin Crowley, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

**Curriculum**

- **60 units minimum**

  - Seven courses (a minimum of 60 units) are required to complete this minor.
  - Entry into the minor requires completion of 73-100 Principles of Economics or 88-220 Policy Analysis I or the equivalent by approval.

**Required Courses**

- **39 units**

Students are required to take the following courses.

- 79-330 Medicine and Society
- 90-836 Health Systems
- 90-861 Health Policy
- 94-705 Health Economics
- 27 units

**Elective Courses**

Complete a minimum of 27 units.

| 90-708 Healthcare Ethics                | 6     |
| 90-721 Healthcare Management           | 6     |
| 90-818 Health Care Quality & Performance Improvement | 6     |
| 90-830 Introduction to Financial Management of Health Care | 6     |
| 90-831 Advanced Financial Management of Health Care | 6     |
| 90-832 Health Law                      | 12    |
| 90-863 Health Policy II                | 6     |
| 94-706 Healthcare Information Systems  | 12    |

| 76-494 Health Economics                | 9     |
| 79-355 Drug Use and Drug Policy        | 9     |
| 79-383 Epidemic Disease and Public Health | 9     |
| 80-245 Medical Ethics                  | 9     |
| 80-247 Ethics and Global Economics     | 9     |
| 85-241 Social Psychology               | 9     |
| 85-442 Health Psychology               | 9     |
| 85-446 Psychology of Gender            | 9     |

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.
Additional Major in Human-Computer Interaction
Robert Kraut, Undergraduate Advisor
Office: Newell Simon Hall (NSH) 3515
For up to date information, see: http://www.hcii.cmu.edu/applying-undergraduate-major

Overview
Human-Computer Interaction (HCI) is a fast growing field devoted to the design, implementation, and evaluation of interactive computer-based technology. Examples of HCI products include intelligent computer tutors, wearable computers, social networking sites, and internet connected personal digital assistants (PDAs). Constructing an HCI product is a cyclic, iterative process that has at least three stages: Design, Implementation, and Evaluation.

The Design stage involves principles of design and human behavior, the Implementation stage principles of computer science, and the Evaluation stage empirical research methods common to several disciplines. There are thus four topical areas to cover in this major: Human Behavior, Design, Implementation, and Evaluation. In slightly more detail, the major involves the following sorts of knowledge and skill:

Design
• Elliciting from the client, formulating, and articulating functional specifications
• Knowing how human factors and cognitive models should inform design
• Knowing the principles of, and having experience with, communication design
• Understanding how implementation constraints should inform design
• Incorporating evaluation results into iterated designs

Implementation Programming Skills
• Standard programming languages - e.g., C++, Java
• Rapid prototyping skill (e.g., Visual Basic, Flash)
• Computational literacy, i.e., knowledge sufficient for effective communication and decision making about:
• Interface construction tools and languages
• Multimedia authoring tools
• Data structures and algorithms
• Operating systems, platforms, etc.

Evaluation
• Experimental design
• Focus Groups
• Surveys
• Usability Testing (Cognitive walkthroughs, user models, heuristic evaluation, GOMS)
• Statistical Analysis

There are over 45 courses relevant to these areas that are now offered by eight different departments in four different colleges at Carnegie Mellon (the School of Computer Science, the College of Humanities and Social Sciences, and the College of Fine Arts, and the Tepper School of Business).

Curriculum

Required Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>or 85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>51-261</td>
<td>Communication Design Fundamentals</td>
<td>9</td>
</tr>
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</table>

Statistics (one of the following):
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>36-207</td>
<td>Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>36-220</td>
<td>Engineering Statistics and Quality Control</td>
<td>9</td>
</tr>
<tr>
<td>36-225-36-226</td>
<td>Introduction to Probability Theory and Introduction to Statistical Inference</td>
<td>18</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
<td>9</td>
</tr>
<tr>
<td>70-207</td>
<td>Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
</tbody>
</table>

Introduction to Programming:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>or 15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td>10</td>
</tr>
<tr>
<td>or 15-121</td>
<td>Introduction to Data Structures</td>
<td>10</td>
</tr>
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Basic Interaction Design:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-421</td>
<td>Basic Interaction</td>
<td>9</td>
</tr>
<tr>
<td>or 51-422</td>
<td>Basic Interaction</td>
<td>9</td>
</tr>
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</table>

Evaluation (one of the following):
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<thead>
<tr>
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<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>36-303</td>
<td>Sampling, Survey and Society</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
<tr>
<td>85-310</td>
<td>Research Methods in Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-340</td>
<td>Research Methods in Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>88-251</td>
<td>Empirical Research Methods</td>
<td>9</td>
</tr>
<tr>
<td>70-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>70-481</td>
<td>Marketing Research</td>
<td>9</td>
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</table>

Human-Computer Interaction Methods
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-410</td>
<td>User-Centered Research and Evaluation</td>
<td>12</td>
</tr>
<tr>
<td>05-120</td>
<td>Interface Programming</td>
<td>12</td>
</tr>
<tr>
<td>05-430</td>
<td>Programming Usable Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>or 05-431</td>
<td>Software Structures for User Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>05-433</td>
<td>User Interface Lab</td>
<td>9</td>
</tr>
</tbody>
</table>

Project Course:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-571</td>
<td>Undergraduate Project in HCI</td>
<td>12</td>
</tr>
</tbody>
</table>

Notes

a The evaluation and statistics courses are required so that majors will be able to understand and conduct empirical research in HCI. Therefore a mathematically-oriented probability course, such as 36-217 Probability Theory and Random Processes does not fulfill either requirement.

b Design majors do not need to take 51-261 Communication Design Fundamentals as a prerequisite, since they learn similar material in other courses for their major. HCI undergraduates taking Communication Design Fundamentals must go to the School of Design office, MM 110, to register for the course on their assigned day. ID will be required.

c HCI double majors are guaranteed a place in 51-422 Basic Interaction, offered every spring by the School of Design for HCI double majors. Students intending to take 51-422 must visit the School of Design office in MM 110 during registration week to fill out an instructor-permission request form. The content of this course is comparable to 51-421 (Fall).

Electives (18 Units)

Electives are intended to provide HCI double majors advanced concepts and skills relevant to HCI or breadth of experience not available from their primary major. Given these goals, most electives will be 300-level courses or higher. Courses at the 100-level and 200-level in one’s primary major will not count as electives, although the same course taken by a non-major may count (approval is still required).

Students can take electives in the HCI or courses relevant to HCI from many other departments on campus. All electives are approved on a case-by-case basis. Undergraduate majors request approval of an elective using The HCI Institute’s EASY requirements’ management system (http://mhciserver1.hcii.cs.cmu.edu/EASY). The director of the undergraduate program will approve the request, ask for more information or reject it. The EASY system then deeps a record of the electives approved for a particular student.

The following courses have been approved as electives in the past, organized by the offering department:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-320</td>
<td>Social Web</td>
<td>12</td>
</tr>
<tr>
<td>05-395</td>
<td>Applications of Cognitive Science</td>
<td>9</td>
</tr>
<tr>
<td>05-413</td>
<td>Human Factors</td>
<td>9</td>
</tr>
<tr>
<td>05-431</td>
<td>Software Structures for User Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>05-540</td>
<td>Rapid Prototyping of Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>05-589</td>
<td>Independent Study in HCI</td>
<td>12</td>
</tr>
<tr>
<td>10-601</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>15-390</td>
<td>Entrepreneurship for Computer Science</td>
<td>9</td>
</tr>
<tr>
<td>15-421</td>
<td>Web Commerce, Security and Privacy</td>
<td>12</td>
</tr>
<tr>
<td>15-437</td>
<td>Web Application Development</td>
<td>12</td>
</tr>
<tr>
<td>15-462</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>15-466</td>
<td>Computer Game Programming</td>
<td>12</td>
</tr>
<tr>
<td>05-571</td>
<td>Undergraduate Project in HCI</td>
<td>12</td>
</tr>
</tbody>
</table>
# Design and Social Change

- **Mathematical Science Elective**

## Undergraduate Colloquium
- **Electives**
  - Introduction to Statistical Inference
  - Advanced Data Analysis
  - Topics in Statistics:
    - Probability and Statistics: 36 Units
      - Differential and Integral Calculus
      - Integration, Differential Equations and Approximation
      - Concepts of Mathematics
      - Matrices and Linear Transformations
      - Calculus in Three Dimensions
      - Undergraduate Colloquium
      - Operations Research I
      - Principles of Real Analysis I
      - Principles of Real Analysis II
      - Probability
      - Cognition, Choice and Behavior
      - Electives
    - Statistics and Data Analysis Electives: 18 Units
      - Complete two courses from the following:
        - Differential and Integral Calculus
        - Concepts of Mathematics
        - Interpretation and Argument
        - Physics for Science Students
        - Computing @ Carnegie Mellon
        - Global Histories
        - Economic, Political and Social Institutions
        - Science
        - Electives
    - Sophomore Year
      - Fall
        - Undergraduate Colloquium
        - Matrices and Linear Transformations
        - Experimental Design for Behavioral and Social Sciences
        - Economic, Political and Social Institutions
        - Science
        - Electives
      - Spring
        - Undergraduate Colloquium
        - Calculus in Three Dimensions
        - Operations Research I
        - Cultural Analysis
        - Electives
    - Junior Year
      - Fall
        - Principles of Real Analysis I
        - Probability
        - Electives
      - Spring
        - Mathematical Science Elective
        - Introduction to Statistical Inference
        - Creative Production & Reflection
        - Electives
    - Senior Year
      - Fall
        - Operations Research II
        - Modern Regression
        - Special Topics: Epidemiology
        - Electives
      - Spring
        - Mathematical Science Elective
        - Advanced Data Analysis
        - Senior Research Elective
        - Electives

- **Bachelor of Science in Music and Technology**
  - The Bachelor of Science in Music and Technology is offered jointly by the School of Music, the School of Computer Science (SCS), and the Carnegie Institute of Technology (CIT).
This program consists of a set of courses that span both music and technology, as well as a capstone composition/design/performance project. Courses in all three areas of study are stipulated in the music and technology undergraduate curriculum and provide for students coming from any of the three areas. In other words, regardless of a student’s entry point — an interest in computer science, electrical engineering, or music — the coursework prescribed will allow the student to gain the requisite knowledge and experience in all three areas. Students will work closely with advisors and will be guided in both course selection and capstone projects.

General Requirements 85 units

<table>
<thead>
<tr>
<th>Seminar</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>57-570 Music and Technology Seminar (8 semesters)</td>
<td>8</td>
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</tbody>
</table>
* for a total of 8 units.

University

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
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<tbody>
<tr>
<td>99-10x Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>76-104 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>79-104 Global Histories</td>
<td>9</td>
</tr>
</tbody>
</table>

Humanities

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx Cognition, Choice and Behavior course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx English, History, Modern Languages, Philosophy, or Psychology course</td>
<td>9</td>
</tr>
</tbody>
</table>

Mathematics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
</tbody>
</table>

Science

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-114 Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>33-106 Physics for Engineering Students</td>
<td>12</td>
</tr>
</tbody>
</table>

Electives 24 units

Music Core 95 units

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-100 Convocation (8 semesters)</td>
<td>8</td>
</tr>
<tr>
<td>57-152 Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>57-153 Harmony II</td>
<td>9</td>
</tr>
<tr>
<td>57-408 Form and Analysis</td>
<td>6</td>
</tr>
<tr>
<td>57-151 Counterpoint in Theory and Application</td>
<td>6</td>
</tr>
<tr>
<td>57-258 20th-21st Century Techniques</td>
<td>6</td>
</tr>
<tr>
<td>57-257 Orchestration I</td>
<td>6</td>
</tr>
<tr>
<td>57-271 Orchestration II</td>
<td>6</td>
</tr>
<tr>
<td>57-189 Introduction to Repertoire and Listening for Musicians</td>
<td>3</td>
</tr>
<tr>
<td>57-190 Repertoire and Listening for Musicians I</td>
<td>3</td>
</tr>
<tr>
<td>57-289 Repertoire and Listening for Musicians II</td>
<td>3</td>
</tr>
<tr>
<td>57-290 Repertoire and Listening for Musicians III</td>
<td>3</td>
</tr>
<tr>
<td>57-181 Solfège I</td>
<td>3</td>
</tr>
<tr>
<td>57-182 Solfège II</td>
<td>3</td>
</tr>
<tr>
<td>57-183 Solfège III</td>
<td>3</td>
</tr>
<tr>
<td>57-184 Solfège IV</td>
<td>3</td>
</tr>
<tr>
<td>57-161 Eurhythmics I</td>
<td>3</td>
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<tr>
<td>57-142 Eurhythmics II</td>
<td>3</td>
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<tr>
<td>57-173 Survey of Western Music History</td>
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</table>

Music and Technology Core 121 units

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110 Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>or 15-121 Introduction to Data Structures</td>
<td></td>
</tr>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>15-322 Introduction to Computer Music</td>
<td>9</td>
</tr>
<tr>
<td>18-100 Introduction to Electrical and Computer Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-202 Mathematical Foundations of Electrical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-290 Signals and Systems</td>
<td>12</td>
</tr>
<tr>
<td>15-101 Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-347 Electronic and Computer Music</td>
<td>6</td>
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<tr>
<td>57-337 Sound Recording</td>
<td>6</td>
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<tr>
<td>57-338 Sound Editing and Mastering</td>
<td>6</td>
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<tr>
<td>57-438 Multitrack Recording</td>
<td>9</td>
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<tr>
<td>57-5Tx Music and Technology Project</td>
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<tr>
<td>57-57x Music and Technology Project</td>
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</table>

Students complete either the Music Concentration or the Technical Concentration:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music Concentration 60 units</td>
<td></td>
</tr>
<tr>
<td>57-5xx Studio (4 semesters)</td>
<td>36</td>
</tr>
<tr>
<td>57-4xx Major Ensemble (4 semesters)</td>
<td>24</td>
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</table>

Technical Concentration 57 or 55 units

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>15/18-213 Introduction to Computer Systems</td>
<td>12</td>
</tr>
</tbody>
</table>

AND EITHER:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-220 Electronic Devices and Analog Circuits</td>
<td>12</td>
</tr>
<tr>
<td>18-240 Structure and Design of Digital Systems</td>
<td>12</td>
</tr>
<tr>
<td>15-2xx/18-3xx Electives in ECE or CS or above</td>
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</table>

OR:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-128 Freshman Immigration Course</td>
<td>1</td>
</tr>
<tr>
<td>15-213 Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>15-323 Computer Music Systems and Information Processing</td>
<td>9</td>
</tr>
<tr>
<td>15-2xx/18-3xx Electives in ECE or CS or above</td>
<td></td>
</tr>
</tbody>
</table>

Total number of units required for major 380

Major in Psychology & Biological Sciences

This major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences.

Note: Students entering from the College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the Mellon College of Science will earn a Bachelor of Science in Biological Sciences and Psychology. Students in the joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Depending on a student’s home college (H&SS or MCS), General Education (GenEd) requirements will be different. GenEd requirements for H&SS (p.168) and MCS (p. 253) are found on their respective Catalog pages.

Degree Requirements:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Biological Sciences</td>
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<tr>
<td>03-321 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231 Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-201/202 Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxx General Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xxx Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xxx Advanced Biology Elective</td>
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</tr>
<tr>
<td>Total Biology units</td>
<td>79</td>
</tr>
<tr>
<td>Mathematics, Statistics, Physics and Computer Science</td>
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</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>01-124 Calculus II for Biologists and Chemists</td>
<td>9</td>
</tr>
<tr>
<td>36-247 Statistics for Lab Sciences</td>
<td>9</td>
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<tr>
<td>36-309 Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
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<tr>
<td>33-112 Physics I for Science Students</td>
<td>12</td>
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<tr>
<td>33-112 Physics II for Science Students</td>
<td>32</td>
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<tr>
<td>15-110 Principles of Computing *</td>
<td>10</td>
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<tr>
<td>99-10x Computing at Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>Total Science units</td>
<td>75</td>
</tr>
</tbody>
</table>

* 15-101 Exploring Programming with Alice can substitute for 15-110 towards completion of the Programming course requirement.

Carnegie Mellon University
The Science and Humanities Scholars (SHS) program is for students who wish to build upon a solid academic foundation in the humanities, social sciences, natural sciences, and mathematics. Students in this program enroll in either the Mellon College of Science (MCS) or the College of Humanities and Social Sciences (H&SS). While every student at the university may elect to pursue multi- and interdisciplinary studies, the SHS General Education curriculum assures that students in the program can develop the background for any field of study or combination of studies across both MCS and H&SS.

SHS students in their first year may elect to live in a Stever House residential cluster that promotes the integration of academic and social interests. As upper-class students, they are eligible to live in upper-class housing reserved for interdisciplinary students and may continue to participate in occasions that foster their intellectual community. The program additionally supports students through the creation of interdisciplinary and multidisciplinary courses.

Before a student declares a major, the program director serves as the student’s primary academic advisor, complementing the range of other advising available around the university. After a student declares a major, the director continues to provide supplementary advising for the student, especially on matters of General Education.

Entering first-year students with outstanding credentials who applied to H&SS or MCS may receive an invitation to the SHS Program. Those invited should carefully consider whether this academic program matches their own scholarly interests. Students enrolled in either college may also request to transfer into the Science and Humanities Scholars Program after completing at least one semester at the university.

Science and Humanities Scholars General Education Program

There are 14 requirements in the SHS General Education Program. The curriculum is designed to expose students to a variety of subjects and methodologies, in order to enable them to become better citizens of the world and more complete scholars with a comprehensive range of possible major choices. The SHS curriculum allows for flexibility and independence in selecting courses to fulfill these General Education requirements, and in many cases students in the Program can petition the Director to take alternate courses in addition to the ones listed here.

Mathematical Sciences (20 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-130</td>
<td>Introduction to Ethics</td>
<td>9</td>
</tr>
<tr>
<td>80-150</td>
<td>Nature of Reason</td>
<td>9</td>
</tr>
<tr>
<td>80-180</td>
<td>Nature of Language</td>
<td>9</td>
</tr>
<tr>
<td>80-221</td>
<td>Philosophy of Social Science</td>
<td>9</td>
</tr>
<tr>
<td>80-230</td>
<td>Ethical Theory</td>
<td>9</td>
</tr>
<tr>
<td>80-241</td>
<td>Ethical Judgments in Professional Life</td>
<td>9</td>
</tr>
<tr>
<td>80-270</td>
<td>Philosophy of Mind</td>
<td>9</td>
</tr>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-221</td>
<td>Principles of Child Development</td>
<td>9</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-251</td>
<td>Personality</td>
<td>9</td>
</tr>
<tr>
<td>85-261</td>
<td>Abnormal Psychology</td>
<td>9</td>
</tr>
<tr>
<td>88-120</td>
<td>Reason, Passion and Cognition</td>
<td>9</td>
</tr>
</tbody>
</table>

Writing/Expression (9 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>70-104</td>
<td>Global Histories</td>
<td>9</td>
</tr>
</tbody>
</table>

World Cultures (9 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>15-221</td>
<td>Introduction to Data Structures</td>
<td>10</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>80-210</td>
<td>Logic and Proofs</td>
<td>9</td>
</tr>
<tr>
<td>80-211</td>
<td>Logic and Mathematical Inquiry</td>
<td>9</td>
</tr>
<tr>
<td>80-212</td>
<td>Arguments and Logical Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Freshman Seminar (6-9 units)

Students may select an SHS seminar, a full-semester seminar from H&SS, or two half-semester freshman seminars from MCS and/or H&SS from a list of courses provided every semester.

Science Core (28 units)

Choose three of the following courses. Science majors with primary majors in the Mellon College of Science must complete at least two that are outside of their major department.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-131</td>
<td>Matter and Interaction I</td>
<td>12</td>
</tr>
<tr>
<td>33-132</td>
<td>Matter and Interactions II</td>
<td>12</td>
</tr>
</tbody>
</table>

Distribution Requirements (36 units)

Choose a minimum of four courses, at 9 units per category, totaling at least 36 units. Below are examples of courses satisfying these categories. You are encouraged to identify other courses that could fulfill these requirements; see the SHS Director for prior approval.

Cognition, Choice, and Behavior

Courses in this category use model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

<table>
<thead>
<tr>
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<th>Units</th>
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</thead>
<tbody>
<tr>
<td>80-130</td>
<td>Introduction to Ethics</td>
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</tr>
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<td>88-120</td>
<td>Reason, Passion and Cognition</td>
<td>9</td>
</tr>
</tbody>
</table>
Economic, Political, and Social Institutions

Courses in this category examine the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

36-303 Sampling, Survey and Society
70-332 Business, Society and Ethics
73-100 Principles of Economics
73-230 Intermediate Microeconomics
79-266 Russian History: from Communism to Capitalism
79-331 Body Politcs: Women and Health in America
79-335 Drug Use and Drug Policy
79-340 Gender, Race, and American Sport: Historical and Contemporary Perspectives
79-345 The Roots of Rock and Roll, 1870-1970
79-350 Early Christianity
80-135 Introduction to Political Philosophy
80-136 Social Structure, Public Policy & Ethics
80-235 Political Philosophy
80-243 Business Ethics
80-341 Computers, Society and Ethics
88-104 Decision Processes in American Political Institutions
88-184 Topics of Law: The Bill of Rights
88-205 Comparative Politics

Creative Production and Reflection

Courses in this category encourage exploration of the artistic and intellectual creation of others while allowing for personal expression and reflection upon the creative process.

xx-xxx Courses from the College of Fine Arts (Architecture 48-xxx, Design 51-xxx, Drama 54-xxx, Music 57-xxx, Art 60-xxx, CFA Interdisciplinary 62-xxx)
76-260 Survey of Forms: Fiction
76-262 Survey of Forms: Nonfiction
76-265 Survey of Forms: Poetry
76-269 Survey of Forms: Screenwriting
80-220 Philosophy of Science
82-1xx Any Elementary Modern Language course
82-2xx Any Intermediate Modern Language course
99-241 Revolutions of Circularity

Cultural Analysis

Courses in this category explore definitions of culture and the role culture plays in producing different actions and institutions, as well as the roles of institutions, systems, and human actions in shaping cultural contexts.

57-173 Survey of Western Music History
70-342 Managing Across Cultures
76-227 Comedy
76-232 African American Literature
76-241 Introduction to Gender Studies
79-113 Culture and Identity in American Society
79-311 Introduction to Anthropology
79-240 The Development of American Culture
79-207 Development of European Culture
79-345 The Roots of Rock and Roll, 1870-1970
79-241 African American History: Africa to the Civil War
79-242 Topics in African American History: Reconstruction to the Present
79-224 Mayan America
79-261 Chinese Culture and Society
79-368 Poverty, Charity, and Welfare
79-330 Medicine and Society
80-100 Introduction to Philosophy
80-250 Ancient Philosophy
80-251 Modern Philosophy
80-253 Continental Philosophy
80-254 Analytic Philosophy
80-255 Pragmatism
80-261 Empiricism and Rationalism
82-273 Introduction to Japanese Language and Culture
82-294 Topics in Russian Language and Culture
82-303 French Culture
82-304 The Francophone World
82-333 Introduction to Chinese Language and Culture
82-342 Spain: Language and Culture
82-343 Latin America: Language and Culture
82-344 U.S. Latinos: Language and Culture
82-345 Introduction to Hispanic Literary and Cultural Studies
82-396 The Faust Legend at Home and Abroad
82-415 Topics in French and Francophone Studies
82-426 Topics in German Literature and Culture
82-451 Studies in Latin American Literature and Culture
82-491 Literature, Politics and Film in Russia & East Europe Today

Major Programs

A number of majors that reflect the interdisciplinary nature of research and teaching between the physical and natural sciences, humanities, mathematics, and social/behavioral sciences have been introduced, or are under development, inspired in part by the SHS program. Two are presented here (in Biological Sciences and Psychology, and in Mathematical and Statistical Sciences) and are now available to students.
BXA Intercollege Degree Programs

Mission Statement

The BXA Intercollege Degree Programs are designed for students who want to turn talent and passion into viable professions for the future through a challenging academic regimen. BXA students pursue their goals with the help of multifaceted advising, innovative pedagogical strategies, and a focus on the impact arts have on technology and vice versa.

The goal of the Bachelor of Humanities and Arts (BHA), the Bachelor of Science and Arts (BSA), and the Bachelor of Computer Science and Arts (BCSA) BXA Intercollege Degree Programs is to allow a select group of students who demonstrate interest and accomplishment in the fine arts and the humanities, social sciences or natural sciences, computer science, and emerging media to explore beyond the traditional academic major, or integrate more than one field of study across disciplines. These programs foster the creativity of students who explore innovative approaches to the academic environments of two colleges. By merging the components in the arts and humanities, natural sciences, or computer science into an interdisciplinary/multidisciplinary study, a unique, complex product is born. BXA students produce new information, challenging questions, and innovative theory. BXA students are models of independence, motivation, and well-rounded scholarship as humanists, scientists, and artists at the same time.

In the context of the Carnegie Mellon University environment, the BXA Intercollege Degree Programs hold a special role. BXA provides access to four strong colleges that offer specialized training with expert faculty and researchers. The BXA Programs challenge students to utilize those resources as they explore and develop their own approach to interdisciplinary studies in the fine arts and the humanities and social sciences, the natural and mathematical sciences, or computer science.

BXA students balance courses in their CFA concentration with courses in their academic concentration, as well as BXA-specific courses. These BXA-specific courses give students the opportunity to integrate their areas of concentration by focusing on interdisciplinary approaches and arts-based research techniques. The curricula in the concentration areas provide students with a solid disciplinary foundation upon which they can draw for interdisciplinary projects.

A BXA Intercollege degree prepares students for graduate study and careers in an enormous variety of fields, including traditional graduate training in the arts as well as academic areas, positions in arts and education non-profits such as museums and foundations, and technical positions with media and technology companies.

Program Objectives

The skills developed by BXA students span the creative, the technical, the academic, and the practical. The objective of the BXA Intercollege Program is to prepare graduates for careers in which they will draw on their creative and academic skills to create, educate, communicate, and innovate across disciplines.

Students who complete the BXA curriculum will graduate with the following skills:

- Foundational knowledge and technical expertise in the CFA concentration area and the DC/MCS/SCS concentration area
- Ability to describe the connections between these concentrations and how the student integrates them
- Ability to communicate ideas textually, visually, and orally
- Knowledge of how the concentration disciplines intersect with history, society, and culture from local and global perspectives
- Ability to use cognitive, behavioral, and ethical dimensions within the concentration disciplines to make decisions on individual and social levels
- Experience in engaging in art research to produce new knowledge both within the CFA concentration and the DC/MCS/SCS concentration
- Experience in designing, researching, and completing a large-scale, object-based project that integrates both areas of concentration

Bachelor of Humanities and Arts Degree Program

Carnegie Mellon University offers an intercollege degree that combines the strengths of the College of Fine Arts (CFA) and the College of Dietrich College of Humanities and Social Sciences (DC). The intercollege degree, called the Bachelor of Humanities and Arts (BHA), offers depth of study in both the fine arts and the humanities, social and behavioral sciences. The BHA Degree Program enables a student to receive broader exposure to the humanities and liberal arts than is generally possible through a Bachelor of Fine Arts degree in CFA, while obtaining deeper and more substantial training in the fine arts than is generally possible through a Bachelor of Arts or Bachelor of Science degree in DC. Students receive extensive training in one or more of the fine arts disciplines as well as related advanced training in areas such as writing, social sciences, behavioral sciences, or cultural studies. The program also provides enough flexibility to allow students to explore other areas of interest. The most important aspect of the BHA Program is for students to blend their interests, and to explore the connections between their chosen disciplines.

The BHA curriculum is divided into three parts: 1) General Education coursework, 2) CFA concentration coursework, and 3) DC concentration coursework.

Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama, or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BHA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school. Students choose their humanities or social/behavioral sciences concentration from the list of majors and minors offered by DC, or by self-designing an interdepartmental concentration.

The BHA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BXA Intercollege Degree Programs. The director and associate director/academic advisor of the BXA Intercollege Degree Programs are the primary advisors and liaisons between CFA and DC. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA for their fine arts concentration, and an advisor in DC for their humanities/social sciences concentration. This network of advisors guides each student through their curriculum.

Masters of Arts Management (MAM) Option

BHA students who have an interest in arts management and wish to go on for an advanced degree may select courses in their sophomore and junior years to prepare them for this area. A student in the junior year may apply to the Accelerated Master’s Program with the School of Public Policy & Management at Heinz College. In this program students take both graduate and undergraduate courses in the senior year, earn the BHA degree, and continue on for an additional year to complete the work for the Masters of Arts Management (MAM) degree.

BHA Curriculum

(Total BHA Degree Requirements 378)

I. BHA General Education (GenEd)

14 courses, 111 units minimum

- Communicating: Language and Interpretations (3 courses, 27 units minimum, 76-101 required, two approved modern language courses required)
- Reflecting: Societies and Cultures (1 course, 9 units minimum, 79-104 required)
- Modeling: Mathematics and Experiments (1 course, 9 units minimum)
- Deciding: Social Sciences and Values (3 courses, 27 units minimum, 36-201 required)
- BXA Freshman Research Seminar (1 course, 9 units, 62-190 required)
- BXA Junior Seminar (1 course, 9 units, 62-410 required)
- BXA Junior Portfolio Review (complete 1 required review, 0 units, 62-391 required)
- BXA Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, required in first semester)

**Communicating: Language and Interpretations (3 courses, complete 27 units minimum)**

Courses in this category give special attention to the study of language as interpretation, expression and argument within and across multiple disciplines. Students examine language for its internal logics and structures.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-101</td>
<td>Interpretation and Argument -REQUIRED</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(various topics by section) <a href="http://www.cmu.edu/undergraduate/fall.html">link</a></td>
<td></td>
</tr>
<tr>
<td>80-xxx</td>
<td>Modern Languages -REQUIRED</td>
<td>18</td>
</tr>
</tbody>
</table>

Complete two courses taught in a language offered by the Modern Language Department. A wide selection of courses are offered in Arabic, Chinese Studies, European Studies, French and Francophone Studies, German Studies, Hispanic Studies, Italian, Japanese Studies, Russian Studies, and Spanish. Students must complete two courses in the same language. Languages taught at other institutions are also acceptable (with advisor approval).

**Reflecting: Societies and Cultures (1 course, complete 9 units minimum)**

This category emphasizes the study of history, society, and culture from local and global perspectives.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-104</td>
<td>Global Histories -REQUIRED</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(various topics by section) <a href="http://www.history.cmu.edu/undergraduate/fall.html">link</a></td>
<td></td>
</tr>
</tbody>
</table>

Modeling: Mathematics and Experiments (1 course, complete 9 units minimum)

Courses in this category stress the interplay of mathematical (formal) theories and experimental work. Some courses investigate the internal structure of theories, whereas others use them as models for producing real-world knowledge. Such models may be drawn from a variety of disciplines including the natural sciences, but also, for example, psychology and computer science. The interactions between theorizing and experimenting (observing) can be understood within an intellectual framework that invites comparative assessment. Select one course from the following course options:

**Mathematics**

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>21-110</td>
<td>Problem Solving in Recreational Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-111</td>
<td>Calculus I</td>
<td>10</td>
</tr>
<tr>
<td>21-112</td>
<td>Calculus II</td>
<td>10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
<td>9</td>
</tr>
<tr>
<td>22-127</td>
<td>Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>80-110</td>
<td>Nature of Mathematical Reasoning</td>
<td>9</td>
</tr>
<tr>
<td>80-210</td>
<td>Logic and Proofs</td>
<td>9</td>
</tr>
<tr>
<td>80-211</td>
<td>Logic and Mathematical Inquiry</td>
<td>9</td>
</tr>
<tr>
<td>80-212</td>
<td>Arguments and Logical Analysis</td>
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</tbody>
</table>

**Natural Science**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-122</td>
<td>Organismic Botany</td>
<td>9</td>
</tr>
<tr>
<td>03-125</td>
<td>Evolution and History of Life</td>
<td>9</td>
</tr>
<tr>
<td>03-203</td>
<td>Bericht zu Bedı́de: Process of Regenerative Therapeutics</td>
<td>6</td>
</tr>
<tr>
<td>03-201</td>
<td>Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-202</td>
<td>Biochemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-101</td>
<td>Introduction to Experimental Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-103</td>
<td>Atoms, Molecules and Chemical Change</td>
<td>9</td>
</tr>
<tr>
<td>09-104</td>
<td>Fundamental Aspects of Organic Chemistry and Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-222</td>
<td>Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>12-201</td>
<td>Geology</td>
<td>9</td>
</tr>
<tr>
<td>33-100</td>
<td>Basic Experimental Physics</td>
<td>6</td>
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<tr>
<td>33-104</td>
<td>Experimental Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-106</td>
<td>Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>33-107</td>
<td>Physics II for Engineering Students</td>
<td>9</td>
</tr>
<tr>
<td>33-111</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>33-112</td>
<td>Physics II for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>33-114</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>33-115</td>
<td>Physics for Future Presidents</td>
<td>9</td>
</tr>
<tr>
<td>33-124</td>
<td>Introduction to Astronomy</td>
<td>9</td>
</tr>
<tr>
<td>33-131</td>
<td>Matter and Interaction I</td>
<td>12</td>
</tr>
<tr>
<td>33-132</td>
<td>Matter and Interactions II</td>
<td>12</td>
</tr>
<tr>
<td>33-211</td>
<td>Physics III: Modern Essentials</td>
<td>10</td>
</tr>
<tr>
<td>33-213</td>
<td>Mini-Course in Special Relativity</td>
<td>4</td>
</tr>
<tr>
<td>33-224</td>
<td>Stars, Galaxies and the Universe</td>
<td>9</td>
</tr>
<tr>
<td>33-355</td>
<td>Nanoscience and Nanotechnology</td>
<td>9</td>
</tr>
</tbody>
</table>

**Other Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>05-291</td>
<td>HCI for Computer Scientists</td>
<td>12</td>
</tr>
<tr>
<td>05-413</td>
<td>Human Factors</td>
<td>9</td>
</tr>
<tr>
<td>06-100</td>
<td>Introduction to Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>09-109</td>
<td>Kitchen Chemistry Sessions</td>
<td>3</td>
</tr>
<tr>
<td>09-209</td>
<td>Kitchen Chemistry Sessions</td>
<td>3</td>
</tr>
<tr>
<td>12-100</td>
<td>Introduction to Civil and Environmental Engineering</td>
<td>12</td>
</tr>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>15-121</td>
<td>Introduction to Data Structures</td>
<td>10</td>
</tr>
<tr>
<td>18-100</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>12</td>
</tr>
<tr>
<td>19-101</td>
<td>Introduction to Engineering and Public Policy</td>
<td>12</td>
</tr>
<tr>
<td>24-101</td>
<td>Fundamentals of Mechanical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>27-100</td>
<td>Engineering the Materials of the Future</td>
<td>12</td>
</tr>
<tr>
<td>33-120</td>
<td>Science and Science Fiction</td>
<td>9</td>
</tr>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>42-101</td>
<td>Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>79-382</td>
<td>History of Biomedical Research</td>
<td>9</td>
</tr>
<tr>
<td>80-220</td>
<td>Philosophy of Science</td>
<td>9</td>
</tr>
<tr>
<td>80-226</td>
<td>Revolutions in Science</td>
<td>9</td>
</tr>
<tr>
<td>80-312</td>
<td>Philosophy of Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>80-313</td>
<td>Philosophical Logic</td>
<td>9</td>
</tr>
<tr>
<td>80-322</td>
<td>Philosophy of Physics</td>
<td>9</td>
</tr>
<tr>
<td>80-323</td>
<td>Philosophy of Biology</td>
<td>9</td>
</tr>
<tr>
<td>85-355</td>
<td>Introduction to Cognitive Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-370</td>
<td>Perception</td>
<td>9</td>
</tr>
<tr>
<td>85-392</td>
<td>Human Expertise</td>
<td>9</td>
</tr>
<tr>
<td>85-406</td>
<td>Autism: Psychological and Neuroscience Perspectives</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-414</td>
<td>Cognitive Neuropsychology</td>
<td>9</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
<tr>
<td>85-423</td>
<td>Cognitive Development</td>
<td>9</td>
</tr>
<tr>
<td>85-429</td>
<td>Cognitive Brain Imaging</td>
<td>9</td>
</tr>
<tr>
<td>88-360</td>
<td>Behavioral Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-391</td>
<td>Technology and Economic Growth</td>
<td>9</td>
</tr>
<tr>
<td>99-238</td>
<td>Materials, Energy and Environment</td>
<td>9</td>
</tr>
</tbody>
</table>

* Indicates co-requisites and/or prerequisites required.

**Deciding: Social Sciences and Values (3 courses, complete 27 units minimum)**

The theme of this category is the exploration of cognitive, behavioral and ethical dimensions of decision-making on both the individual and social level. Making decisions requires a broad understanding of human rationality and social interaction. Some courses examine the critical collection and analysis of data for achieving such an understanding, whereas others emphasize the historical development of policies and values, which form the matrix for decision-making.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice -REQUIRED</td>
<td>9</td>
</tr>
<tr>
<td>36-207</td>
<td>Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>36-220</td>
<td>Engineering Statistics and Quality Control</td>
<td>9</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Life Sciences</td>
<td>9</td>
</tr>
<tr>
<td>36-303</td>
<td>Sampling, Survey and Society</td>
<td>9</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>79-313</td>
<td>Objects of Value</td>
<td>9</td>
</tr>
<tr>
<td>79-342</td>
<td>Introduction to Science and Technology Studies</td>
<td>9</td>
</tr>
</tbody>
</table>
BXA Freshman Research Seminar (1 course, 9 units)

Section B of the BXA Freshman Research Seminar introduces first-year students to the field of interdisciplinary work and arts-based research. Students engage with theoretical and practical readings from across the various concentrations, with particular emphasis on aesthetic theory. Guest lectures complement the weekly readings by giving insight into practical implementations of these ideas. Students will conceive, research, and create a final project to be presented at the end of the semester.

Section A of the BXA Research Freshman Seminar has been designed for internal transfer students only and it is offered in the fall and spring semesters. Using the arts as primary modes of inquiry, this course’s content probes the idiosyncratic field of arts-based research by following the principle that there is no aspect of human life that cannot be studied from aesthetic theory. Guest Lectures complement the weekly readings by giving insight into practical implementations of these ideas. Students will conceive, research, and create a final project to be presented at the end of the semester.

Each student meets individually with a BHA DC Academic Advisor to design their own specific goals for their academic career, and how they are fulfilling them in this reflective essay, as well as how they will extend that integration into the BXA Capstone Project in the senior year. Students should identify their own specific goals for their academic career and how they are fulfilling them in this reflective essay, as well as how they evaluate their performance in light of the programs’ broader pedagogical goals. Students in the BXA program should be working toward being able to:

- describe the connections between their chosen concentration disciplines and to integrate them into their work
- communicate ideas in writing, visual expression, and oral expression
- discuss the intersection of history, society, and culture from local and global perspectives
- synthesize mathematical theories and experimental work to produce real-world knowledge
- use cognitive, behavioral, and ethical dimensions to make decisions on individual and social levels

BXA Capstone Project (2 courses, 18 units)

The BXA Capstone Project gives BXA students the opportunity to demonstrate the extent of their interdisciplinary work over the course of their academic career. The Capstone Project should include elements that span the student’s CFA and DC concentrations (for BHA students), CFA and MCS concentrations (for BSA students), or CFA and SCS concentrations (for BCSA students). The project can be either a scholarly or creative endeavor, and may take one of many possible forms (e.g., a written thesis, a compilation of creative work or works, an experiment and report, a computer program or animation, etc.).

The BXA Capstone sequence covers both semesters of a student’s senior year. In the fall, students are enrolled in 62-401 BXA Capstone Project I (9 units), which meets weekly to discuss strategies for managing research, planning the project, and larger theoretical issues related to interdisciplinary work. At the end of the fall course, students will have produced a Capstone Project proposal, an annotated bibliography, and multiple versions of their project pitch. In the spring, students enroll in 62-402 BXA Capstone Project II (9 units), which has no required classroom time. Instead, students spend the semester doing the research and foundational work necessary for the project, as well as meeting with their faculty and BXA advisors as they create their Capstone Project and prepare to present it at the annual Meeting of the Minds Undergraduate Research Symposium held each May.

Computing @ Carnegie Mellon (1 mini-course, 3 units)

This is a mini-course, pass/no pass, to be completed in the first semester.

II. Dietrich College of Humanities and Social Sciences Concentration

(9 courses, 81 units minimum)

Each student meets individually with a BHA DC Academic Advisor to design an 81 unit DC concentration based on existing DC majors/minors, or by creating a self-defined interdepartmental concentration. Please refer to the DC section of this catalog to review the individual majors and minors offered. Curriculum for several BHA DC concentration options are outlined below and others will be made available in the BXA office throughout the academic year.

A completed DC Concentration Sheet must be approved by the concentration faculty advisor and submitted to the BXA office by the end of the student’s sophomore year.

Anthropology (81 units minimum)

The BHA concentration in Anthropology offers students training in a wide range of ethnographic methods along with a highly developed theoretical understanding of culture. Students examine the evolution, depth, and complexities of ethnography, and explore notions of “culture” in diverse settings, over time and across space. In today’s world, students are increasingly aware of the importance of developing a sophisticated approach to culture and its articulation with changes in the domains of the arts, technology, economies, and politics. The BHA concentration in Anthropology provides students with the tools to link artistic practices to various aspects of globalization.

Students in the Anthropology concentration are required to take an introductory course and
Methods/Theory Course (18 units), two regional courses and two topical courses (36 units), two advanced language courses (18 units), and complete a culminating capstone/independent study (9 units).

Introductory and Methods Courses (2 courses, 18 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-276</td>
<td>The Global &amp; Local: Theory, Practice &amp; History in Anthropology of Globalization</td>
<td>9</td>
</tr>
<tr>
<td>79-297</td>
<td>Dilemmas and Controversies in Anthropology</td>
<td>9</td>
</tr>
<tr>
<td>79-311</td>
<td>Introduction to Anthropology</td>
<td>9</td>
</tr>
<tr>
<td>79-379</td>
<td>Extreme Ethnography</td>
<td>9</td>
</tr>
<tr>
<td>79-380</td>
<td>Ethnographic Methods</td>
<td>9</td>
</tr>
</tbody>
</table>

Anthropological Perspectives (4 courses, 36 units)

Students gain knowledge of specialized theoretical and regional topics by choosing four from the following (36 units):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-220</td>
<td>Caribbean: Cultures and Histories</td>
<td>9</td>
</tr>
<tr>
<td>79-235</td>
<td>Caribbean Cultures</td>
<td>9</td>
</tr>
<tr>
<td>79-261</td>
<td>Chinese Culture and Society</td>
<td>9</td>
</tr>
<tr>
<td>79-262</td>
<td>Modern China</td>
<td>9</td>
</tr>
<tr>
<td>79-277</td>
<td>Globalizing States: Culture, Power, and Politics</td>
<td>9</td>
</tr>
<tr>
<td>79-278</td>
<td>Rights to Representation: Indigenous People and their Media</td>
<td>9</td>
</tr>
<tr>
<td>79-282</td>
<td>Europe and the World</td>
<td>9</td>
</tr>
<tr>
<td>79-295</td>
<td>Race Relations in the Atlantic World</td>
<td>9</td>
</tr>
<tr>
<td>79-299</td>
<td>Trafficking Persons: Children in a Global Context</td>
<td>9</td>
</tr>
<tr>
<td>79-313</td>
<td>Objects of Value</td>
<td>9</td>
</tr>
<tr>
<td>79-315</td>
<td>Hawaii: America’s Pacific Island State</td>
<td>9</td>
</tr>
<tr>
<td>79-317</td>
<td>Art: Anthropology and Empire</td>
<td>9</td>
</tr>
<tr>
<td>79-330</td>
<td>Medical Anthropology</td>
<td>9</td>
</tr>
<tr>
<td>79-375</td>
<td>China’s Environmental Crisis</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: Courses that count toward this category may be taken at another university, and the units transferred to the BHA Concentration under the guidance of the BHA Anthropology faculty advisor.

Language Courses (2 courses, 18 units)

Every student is expected to take two upper level (intermediate or above) language courses (18 units). These courses deepen the immersion in a culture or society that the Anthropology concentration provides a student, and should coordinate with the regional courses selected for the concentration.

Capstone/Independent Study (1 course, 9 units)

Every student is required to do a culminating research project; this may be part of an advanced course (9 units). Students should work with the BHA Anthropology faculty advisor to determine the best method for completing the capstone research project. This project may be complementary to the BHA Capstone Project sequence (62-401 and 62-402) that is completed in the senior year.

Creative Writing (81 units minimum)

In the Creative Writing concentration, BHA students develop their talents in writing fiction, poetry, and other imaginative forms. While studying with faculty members who are practicing poets and prose writers, students read widely in literature, explore the resources of their imaginations, sharpen their critical and verbal skills, and develop a professional attitude toward their writing. The Creative Writing program is based on a conservatory model, made up of faculty and students who have an intense commitment to their work.

Students in the Creative Writing concentration are required to take two of the introductory Survey of Forms courses, ideally in their sophomore year. Choices include Poetry (76-265), Fiction (76-260), Screenwriting (76-269), and Nonfiction (76-261). In order to proceed into the upper level courses in the major (and in each of the genres), students must do well in these introductory courses (receive a grade of A or B). After completing the Survey of Forms courses, students take four workshops in fiction, poetry, screenwriting, or nonfiction. At least two of the workshops must be taken in a single genre. In the writing workshops, students develop their critical and verbal abilities through close writing and analysis of poems, stories, and other literary forms. Their work is critiqued and evaluated by peers and the faculty.

Survey of Forms Courses (2 courses, 18 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-260</td>
<td>Survey of Forms: Fiction</td>
<td>9</td>
</tr>
<tr>
<td>76-261</td>
<td>Survey of Forms: Fiction</td>
<td>9</td>
</tr>
<tr>
<td>76-265</td>
<td>Survey of Forms: Creative Nonfiction</td>
<td>9</td>
</tr>
<tr>
<td>76-269</td>
<td>Survey of Forms: Screenwriting</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: A student must receive a grade of A or B in the Survey of Forms class in a specific genre in order to be eligible to enroll in a workshop of that genre. A student who receives a grade of C in a Survey of Forms course may enroll in a related workshop only with the permission of the workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

Creative Writing Workshops (4 courses, 36 units)

Complete four Creative Writing workshops, at least two in a single genre. Workshops in all genres may be taken more than once for credit.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-365</td>
<td>Beginning Poetry Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-460</td>
<td>Beginning Fiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-462</td>
<td>Advanced Fiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-464</td>
<td>Creative Nonfiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-465</td>
<td>Advanced Poetry Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-469</td>
<td>Advanced Screenwriting Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-4xx</td>
<td>Elective Workshops (various forms)</td>
<td>9</td>
</tr>
</tbody>
</table>

English Electives (3 courses, 27 units)

Complete three courses from the English Department’s offerings. Readings in Forms classes are recommended, as is 76-306 Editing and Publishing. Please consult the list of courses published each semester by the Department for current offerings. Students should discuss curriculum choices with the Creative Writing advisor to determine the best electives for their focus in Creative Writing.

Decision Science (81 units minimum)

Decision Science is grounded in theories and methods drawn from psychology, economics, philosophy, statistics, and management science. Courses in the BHA concentration in Decision Science cover the three aspects of decision science: (a) normative analysis, creating formal models of rational choice; (b) descriptive research, studying how cognitive, emotional, social, and institutional factors affect judgment and choice, and (c) prescriptive interventions, seeking to improve judgment and decision making. In addition to gaining a broad education in the principles of judgment and decision making, students with a concentration in Decision Science gain broadly applicable skills in research design and analysis. They also have the chance to think about and discuss decision making in many different areas.

Disciplinary Perspectives (5 courses, 45 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-243</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-352</td>
<td>Evolutionary Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-355</td>
<td>Introduction to Cognitive Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-414</td>
<td>Cognitive Neuropsychology</td>
<td>9</td>
</tr>
<tr>
<td>85-442</td>
<td>Health Psychology</td>
<td>9</td>
</tr>
<tr>
<td>88-360</td>
<td>Behavioral Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-365</td>
<td>Behavioral Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-377</td>
<td>Attitudes and Persuasion</td>
<td>9</td>
</tr>
<tr>
<td>88-386</td>
<td>Desires and Decisions</td>
<td>9</td>
</tr>
</tbody>
</table>

Research Methods (2 courses, 18 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>88-251</td>
<td>Empirical Research Methods</td>
<td>9</td>
</tr>
</tbody>
</table>

Electives (2 courses, 18 units)

Complete at least 18 units from the following categories of courses. The selected courses may be from one category or from any combination of categories. Note that not all elective courses are offered every year. At least one of these courses (9 units) must be a Department of Social and Decision Sciences course (88-xxx).

Biological and Behavioral Aspects of Decision Making:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>85-243</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-352</td>
<td>Evolutionary Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-355</td>
<td>Introduction to Cognitive Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-414</td>
<td>Cognitive Neuropsychology</td>
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</tr>
<tr>
<td>85-442</td>
<td>Health Psychology</td>
<td>9</td>
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<tr>
<td>88-360</td>
<td>Behavioral Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-365</td>
<td>Behavioral Economics</td>
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</tr>
<tr>
<td>88-377</td>
<td>Attitudes and Persuasion</td>
<td>9</td>
</tr>
<tr>
<td>88-386</td>
<td>Desires and Decisions</td>
<td>9</td>
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</tbody>
</table>

Managerial and Organizational Aspects of Decision Making:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-332</td>
<td>Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>70-381</td>
<td>Marketing I</td>
<td>9</td>
</tr>
<tr>
<td>70-460</td>
<td>Mathematical Models for Consulting</td>
<td>9</td>
</tr>
<tr>
<td>70-481</td>
<td>Marketing Research</td>
<td>9</td>
</tr>
<tr>
<td>88-221</td>
<td>Policy Analysis II</td>
<td>9</td>
</tr>
<tr>
<td>88-341</td>
<td>Organizational Communication</td>
<td>9</td>
</tr>
<tr>
<td>88-419</td>
<td>Negotiation</td>
<td>9</td>
</tr>
<tr>
<td>88-444</td>
<td>Public Policy and Regulation</td>
<td>9</td>
</tr>
<tr>
<td>88-451</td>
<td>Policy Analysis Senior Project</td>
<td>9</td>
</tr>
<tr>
<td>88-452</td>
<td>Policy Analysis Senior Project</td>
<td>12</td>
</tr>
<tr>
<td>88-452</td>
<td>Policy Analysis Senior Project</td>
<td>12</td>
</tr>
</tbody>
</table>

Philosophical and Ethical Perspectives on Decision Making:
The BHA concentration in Ethics, History, and Public Policy (EHPP) provides students with a rigorous, interdisciplinary humanistic and social-scientific education. The concentration in EHPP encourages the development of a broad technical skill set that will benefit students in whatever career they ultimately choose to pursue. Students with a concentration in EHPP learn how to analyze and construct arguments; to evaluate evidentiary statements; to persuade people to agree with their particular claims; to conduct research under time and resource constraints; and to craft policies that address real world problems in a way that is sensitive both to history and competing sets of values. Comprised of courses in the departments of History, Philosophy, Economics, and Decision Science, the BHA concentration in EHPP encourages specialization, internship experiences, and research in a wide range of policy areas.

**Economics Requirement** (1 course, 9 units)

Choose one of the following:

- 79-100 Principles of Economics
- 88-220 Policy Analysis I

**History Core** (2 courses, 21 units)

- 79-300 History of American Public Policy
- 79-360 Historical Evidence and Interpretation

**Philosophy Core** (3 courses, 27 units)

Choose one course from three of the four categories below. No more than 18 units at the 100-level may be counted toward this requirement.

**Ethics (9 units):**

- 80-130 Introduction to Ethics
- 80-250 Ethical Theory

**Political Philosophy (9 units):**

- 80-135 Introduction to Political Philosophy
- 80-235 Political Philosophy

**Foundations of Social Science (9 units):**

- 80-221 Causation, Law, and Social Policy
- 80-337 Philosophy Politics & Economics

**Applied Philosophy (9 units):**

- 80-136 Social Structure, Public Policy & Ethics
- 80-241 Ethical Judgments in Professional Life
- 80-244 Environmental Ethics
- 80-245 Medical Ethics
- 80-247 Ethics and Global Economics
- 80-341 Computers, Society and Ethics
- 80-344 Management, Environment, and Ethics
- 80-348 Health Development and Human Rights
- 80-447 Global Justice

**Elective Courses** (3 courses, 27 units)

Choose any three courses from any of the following categories:

**Engineering and Public Policy:**

- 19-424 Energy and the Environment
- 19-426 Environmental Decision Making
- 19-448 Science, Technology & Ethics

**Business:**

- 70-311 Organizational Behavior
- 70-321 Negotiation and Conflict Resolution
- 70-332 Business, Society and Ethics
- 70-364 Business Law
- 70-365 International Trade and International Law
- 70-430 International Management

**Economics:**

- 73-148 Environmental Economics
- 73-310 Evolution of Economic Ideas and Analysis
- 73-351 Public Finance
- 73-357 Regulation: Theory and Policy
- 73-358 Economics of the Environment and Natural Resources
- 73-359 Benefit-Cost Analysis
- 73-365 Firms, Market Structures, and Strategy
- 73-371 International Trade and Economic Development
- 73-372 International Money and Finance
- 73-375 History of Money and Monetary Policy
- 73-408 Law and Economics
- 73-476 American Economic History

**English:**

- 76-492 Rhetoric of Public Policy

**History:**

- 79-221 Development and Democracy in Latin America
- 79-231 American Foreign Policy 1945-Present
- 79-233 The United States and the Middle East since 1945
- 79-242 Topics in African American History: Reconstruction to the Present
- 79-267 The Soviet Union in World War II: Military, Political and Social History
- 79-303 Pittsburgh and the Transformation of Modern Urban America
- 79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967
- 79-306 Delinquency, Crime, and Juvenile Justice: 1970s to the Present
- 79-320 Women, Politics, and Protest
- 79-331 Body Politics: Women and Health in America
- 79-333 Biology and Society: Evolution Animal Experimentation and Eugenics
- 79-334 Law, Ethics, and the Life Sciences
- 79-335 Drug Use and Drug Policy
- 79-338 Education and Social Reform
- 79-339 Juvenile Delinquency Through Film
- 79-342 Introduction to Science and Technology Studies
- 79-359 Sustainable Innovation: Ideas, Policies & Technologies to Make a Better Planet
- 79-368 Poverty, Charity, and Welfare
- 79-371 African American Urban History
- 79-374 American Environmental History: Critical Issues
- 79-383 Epidemic Disease and Public Health
- 79-389 Stain and Stainism

**Philosophy:**

- 80-241 Ethical Judgments in Professional Life
- 80-256 Modern Moral Philosophy
- 80-305 Racial Choice
- 80-341 Computers, Society and Ethics
- 80-344 Management, Environment, and Ethics
- 80-405 Game Theory

**Social and Decision Sciences:**

- 88-104 Decision Processes in American Political Institutions
- 88-181 Topics in Law 1st Amendment
- 88-223 Decision Analysis and Decision Support Systems
- 88-343 Economics of Technological Change
- 88-345 Perspectives on Industrial Research and Development
Linguistics (81 units minimum)

The BHA Concentration in Linguistics combines courses from the departments of English, Modern Languages, Philosophy and Psychology and the Language Technologies Institute. Linguistics is the study of human language, and it encompasses a broad spectrum of research questions, approaches and methodologies. Some linguists are concerned with the cognitive aspects of language learning, production and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic form and meaning, some from a functional and others from a formal perspective. There are also computational approaches to linguistics with both applied and theoretical goals.

Introductory Course (1 course, 9 units)
80-180 Nature of Language 9

Fundamental Skills Courses (2 courses, 18 units)
Take one course each in two of the following three areas:
Sounds:
80-282 Phonetics and Phonology 9

Structure:
76-389 Rhetorical Grammar 9
80-280 Linguistic Analysis 9
80-283 Syntax and Discourse 9

Meaning:
76-385 Introduction to Discourse Analysis 9
80-383 Meaning in Language 9
80-383 Language in Use 9

Breadth Courses (2 courses, 18 units)
Take one course from each of the following two areas:
Language Learning and Language Cognition:
76-420 Process of Reading and Writing 9
82-270 Learning About Language Learning 9
82-283 Second Language Acquisition: Theories and Research 9
82-585 Topics in Second Language Acquisition 9
85-354 Infant Language Development 9
85-421 Language and Thought 9

Discourse, Society and Culture:
76-318 Communicating in the Global Marketplace 9
76-385 Introduction to Discourse Analysis 9
76-386 Language and Culture 9
82-305 French in its Social Contexts 9
82-311 Arabic Language and Culture I 9
82-312 Arabic Language and Culture II 9
82-333 Introduction to Chinese Language and Culture 9

Elective Courses (4 courses, 36 units)
Take four additional electives. These can be additional courses from the Fundamental Skills courses or Breadth courses listed above, or any other course which is approved by the Director as a linguistics elective. Listed below are the additional electives taught on a regular basis. Additional appropriate courses are offered irregularly or on a one-off basis. The Director will provide students with a list of possible electives each semester, and will assist students in selecting electives which are consistent with their goals and interests.
11-411 Natural Language Processing 12
11-716 Graduate Seminar on Dialog Processing 6
11-721 Grammars and Lexicons 12
11-722 Grammar Formalisms 12
11-761 Language and Statistics 12
11-762 Language and Statistics II 12
15-492 Special Topic: Speech Processing 12
76-373 Topics in Rhetoric: Argument 9
76-378 Literacy: Educational Theory and Community Practice 9
76-451 Topics in Language Study 9

Language Requirement

Students must successfully complete two semesters of consecutive language courses. Students may not test out of this requirement. However, language courses taken at another institution or as part of a study abroad program will typically substitute for a semester of language study.

Professional Writing (81 units minimum)

Professional Writing combines liberal and professional education with a strong foundation in rhetorical studies. The concentration in Professional Writing has a strong career orientation and is specifically designed to prepare students for successful careers as writers and communications specialists in a range of fields: publishing, government, journalism, the non-profit sector, education, public and media relations, corporate communications, advocacy writing, and the arts. The concentration is designed to develop articulate and reflective communications professionals with both the skills needed to enter and negotiate current work contexts (including writing for the web and other digital media) and the analytic and problem-solving skills needed to understand and keep pace with cultural and technological change.

Foundation Courses (4 courses, 36 units)
76-26x Survey of Forms (Nonfiction, Fiction, Poetry, or Screenwriting) 9
76-271 Introduction to Professional and Technical Writing 9
76-373 Topics in Rhetoric: Argument 9
76-390 Style 9

Rhetoric/Language Studies Course (1 course, 9 units)
Students with a concentration in Professional Writing complete one course from designated Rhetoric courses offered and advertised each semester by the English Department. Rhetoric courses focus on understanding the role of language and language practices in both personal and professional contexts. Courses emphasize the relationships between texts and their contexts and pay particular attention to textual features, meaning, processes of reading and writing, and the ways in which language practices vary over time and across situations and cultures. The courses also equip students with explicit techniques for analyzing, understanding, and exploring language practices. The Rhetoric/Language Studies courses may also be taken as part of the concentration requirements for 3 additional, Advanced Writing/Rhetoric courses and include but are not limited to the following list.
76-318 Communicating in the Global Marketplace 9
76-319 Environmental Rhetoric 9
76-355 Leadership, Dialogue, and Change 9
76-378 Literacy: Educational Theory and Community Practice 9
76-385 Introduction to Discourse Analysis 9
76-386 Language and Culture 9
76-387 Narrative & Argument 9
76-389 Rhetorical Grammar 9
76-419 Communication Revolutions & Technologies 9
76-420 Process of Reading and Writing 9
76-451 Topics in Language Study 9
76-457 Topics in Rhetoric 9
76-476 Rhetoric of Science 9
76-492 Rhetoric of Public Policy 9

Advanced Writing/Rhetoric Courses (3 courses, 27 units minimum)
Students with a concentration in Professional Writing complete three Advanced Writing/Rhetoric courses at the 300- or 400-level. Options for these courses include all of the Rhetoric/Language Studies courses listed above plus the writing-focused courses listed below. Additional courses that fulfill these requirements are advertised on a semester-by-semester basis. For help in choosing which of the possible options are most appropriate for various professional goals – journalism, writing for new media, editing and publishing, public relations/ corporate communications, or science and technical writing – consult your English Department advisor and the “Selected Core Courses & Electives for PW Majors” advising sheet available through the English Department. All students with a concentration in PW, regardless of their career focus, are
encouraged to take 76-391 Document Design and 76-487 Web Design (in conjunction with the 3-unit 76-488 Web Design Lab) to extend their skills in writing for print to include information design for digital media. Both courses focus on the role of the writer in these specializations and provide lab instruction in the relevant software and related computer skills.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>39-405</td>
<td>Engineering Design Projects</td>
<td>12</td>
</tr>
<tr>
<td>76-301</td>
<td>Internship</td>
<td>9</td>
</tr>
<tr>
<td>76-359</td>
<td>Planning and Resting Documents</td>
<td>9</td>
</tr>
<tr>
<td>76-360</td>
<td>Literary Journalism Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-372</td>
<td>Topics in Journalism</td>
<td>9</td>
</tr>
<tr>
<td>76-375</td>
<td>Magazine Writing</td>
<td>9</td>
</tr>
<tr>
<td>76-389</td>
<td>Rhetorical Grammar</td>
<td>9</td>
</tr>
<tr>
<td>76-391</td>
<td>Document Design</td>
<td>9</td>
</tr>
<tr>
<td>76-395</td>
<td>Science Writing</td>
<td>9</td>
</tr>
<tr>
<td>76-396</td>
<td>Non-Profit Advocacy: Genres, Methods, and Issues</td>
<td>9</td>
</tr>
<tr>
<td>76-397</td>
<td>Instructional Text Design</td>
<td>9</td>
</tr>
<tr>
<td>76-472</td>
<td>Advanced Journalism</td>
<td>9</td>
</tr>
<tr>
<td>76-474</td>
<td>Software Documentation</td>
<td>9</td>
</tr>
<tr>
<td>76-479</td>
<td>Marketing, Public Relations, and Corporate Communications</td>
<td>9</td>
</tr>
<tr>
<td>76-481</td>
<td>Writing for Multimedia</td>
<td>9</td>
</tr>
<tr>
<td>76-487</td>
<td>Web Design (take with 76-488 Web Design Lab, 3 units)</td>
<td>12</td>
</tr>
<tr>
<td>76-491</td>
<td>Rhetorical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>76-494</td>
<td>Healthcare Communications</td>
<td>9</td>
</tr>
</tbody>
</table>

**English Elective (1 course, 9 units)**

Students with a concentration in Professional Writing complete one additional course from the English Department’s offerings. This course should be one that focuses on the relationships between texts and their cultural and historical contexts. Courses in literature, cultural studies, rhetoric, and media studies that meet this requirement are advertised on a semester-by-semester basis. The English Elective may be any course offered by the Department with the exception of 76-270 Writing for the Professions and 76-272 Language in Design, both of which are designed for non-majors and overlap with 76-271 Introduction to Professional and Technical Writing. Students with a concentration in PW are additionally encouraged to supplement their PW coursework with 76-300 Professional Seminar (3 units) to learn more about internship and career options in professional writing. 76-300 meets once per week and is offered every fall semester.

**Psychology (81 units minimum)**

Psychology is a science that embraces both biological and social sciences. It is a science concerned with establishing principles and laws regarding the ways in which people think, feel, and behave through the scientific study of human behavior. Students with a concentration in Psychology are expected not only to learn about findings already established by psychologists, but also to become proficient in the investigation and analysis of behavior. This includes observing behavior, formulating hypotheses, designing experiments to test these hypotheses, running experiments, performing statistical analyses, and writing reports.

**Breadth Courses (4 courses, 36 units)**

To gain familiarity with the breadth of the field of Psychology, students take 85-102 Introduction to Psychology and three survey courses.

**Required Intro Course:**

85-102 Introduction to Psychology 9

**Survey Courses:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>or 85-213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85-219</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-221</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>85-241</td>
<td>Principles of Child Development</td>
<td>9</td>
</tr>
<tr>
<td>85-251</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-251</td>
<td>Personality</td>
<td>9</td>
</tr>
</tbody>
</table>

**Research Methods and Statistics (2 courses, 18 units)**

Students complete one course in Research Methods (9 units). The corresponding survey course is prerequisite for this course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-310</td>
<td>Research Methods in Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-320</td>
<td>Research Methods in Developmental Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-340</td>
<td>Research Methods in Social Psychology</td>
<td>9</td>
</tr>
</tbody>
</table>

The following Statistics course is a prerequisite or co-requisite for all the Research Methods courses. This Statistics course counts toward the Psychology concentration.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

**Advanced Courses (3 courses, 27 units)**


**III. College of Fine Arts Concentration**

(number of courses vary, 108 units minimum)

BHA students choose one of the following concentrations:

- Architecture (108 units)
- Art (108 units)
- Design (108 units)
- Drama (108 units)
- Music (108 units)

**Architecture Concentration (108 units minimum)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-100</td>
<td>Architecture Design Studio: Foundation I - Fall</td>
<td>9</td>
</tr>
<tr>
<td>or 48-095</td>
<td>Spatial Concepts for Non-Architects</td>
<td>9</td>
</tr>
<tr>
<td>48-130</td>
<td>Architectural Drawing I: A Tactile Foundation - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-135</td>
<td>Architectural Drawing II: Appearance - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-240</td>
<td>Historical Survey of World Architecture and Urbanism - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
</tbody>
</table>

**Work with Architecture Advisor to Form Concentration. Please Review the Following Suggested Curricula Areas of Elective Focus.**

**Elective Focus: General Education in Architecture (54 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statistics (prerequisite: 33-106 or 48-116) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 12-235 or 48-210) - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 48-207 or 48-210) - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-3xx</td>
<td>Drawing Elective</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural Representation and Visualization (57 units)**

This sequence is intended to develop particular skills in architectural representation.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-120</td>
<td>Introduction to Digital Media I - Fall</td>
<td>6</td>
</tr>
<tr>
<td>48-125</td>
<td>Introduction to Digital Media II (prerequisite: 48-210) - Spring</td>
<td>6</td>
</tr>
<tr>
<td>48-3xx</td>
<td>Drawing Elective</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Graduate Representation/Visualization Elective (pre-approval of coursework required)</td>
<td>18</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Graduate Representation/Visualization Elective (pre-approval of coursework required)</td>
<td>18</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural Technology (54 units)**

This sequence is intended to develop intellectual links to the technical aspects of the profession.

**Prerequisite Courses:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-116</td>
<td>Building Physics</td>
<td>9</td>
</tr>
<tr>
<td>62-175</td>
<td>Descriptive Geometry</td>
<td>6</td>
</tr>
</tbody>
</table>

**Elective Courses:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statistics (prerequisite: 33-106 or 48-116) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 12-235 or 48-210) - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 12-207 or 48-210) - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate &amp; Energy - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-412</td>
<td>Environment II: Mechanical Systems (prerequisite: 48-105) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Designated Departmental Technical Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural History (six varying topics, 54 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-xxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
</tbody>
</table>

**Art Concentration (108 units minimum)**

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

**Concept Studies (2 courses, 20 units)**

Complete two courses:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-101</td>
<td>Concept Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-201</td>
<td>Concept Studio II</td>
<td>10</td>
</tr>
<tr>
<td>60-202</td>
<td>Concept Studio III</td>
<td>10</td>
</tr>
<tr>
<td>60-203</td>
<td>Concept Studio: EcoArt</td>
<td>10</td>
</tr>
<tr>
<td>60-204</td>
<td>Concept Studio: Networked Narrative</td>
<td>10</td>
</tr>
<tr>
<td>60-150</td>
<td>2D Media Studio: Drawing</td>
<td>10</td>
</tr>
<tr>
<td>60-160</td>
<td>2D Media Studio: Imaging</td>
<td>10</td>
</tr>
<tr>
<td>60-250</td>
<td>2D Media Studio: Painting</td>
<td>10</td>
</tr>
<tr>
<td>60-251</td>
<td>2D Media Studio: Print Media</td>
<td>10</td>
</tr>
<tr>
<td>60-130-60-130</td>
<td>3D Media Studio I and 3D Media Studio I (complete two minis, 5 units each)</td>
<td>10</td>
</tr>
<tr>
<td>60-131-60-131</td>
<td>3D Media Studio II and 3D Media Studio II (complete two minis, 5 units each)</td>
<td>10</td>
</tr>
<tr>
<td>60-110</td>
<td>Electronic Media Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-210</td>
<td>Electronic Media Studio II</td>
<td>10</td>
</tr>
<tr>
<td>60-410</td>
<td>20-429 Advanced Electronic and Time-Based Work (ETB)</td>
<td>10</td>
</tr>
<tr>
<td>60-430</td>
<td>20-447 Advanced Sculpture, Installation and Site-Work (SIS)</td>
<td>10</td>
</tr>
<tr>
<td>60-448</td>
<td>20-448 Advanced Contextual Practice (CP)</td>
<td>10</td>
</tr>
<tr>
<td>60-450</td>
<td>20-498 Advanced Drawing, Painting, Print Media and Photography (DP3)</td>
<td>10</td>
</tr>
<tr>
<td>60-499</td>
<td>Studio Independent Study (one only)</td>
<td>10</td>
</tr>
<tr>
<td>60-205</td>
<td>Modern Visual Culture 1879-1945</td>
<td>9</td>
</tr>
<tr>
<td>60-206</td>
<td>Contemporary Visual Culture from 1945 to the Present</td>
<td>9</td>
</tr>
<tr>
<td>51-101</td>
<td>Design Studio I - Fall, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>51-102</td>
<td>Design Studio II - Spring, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>51-103</td>
<td>Design Workshop - Fall, Freshman year</td>
<td>3</td>
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<tr>
<td>51-104</td>
<td>Design Workshop - Spring, Freshman year</td>
<td>4.5</td>
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<tr>
<td>51-121</td>
<td>Design Drawing I - Fall, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>51-122</td>
<td>Design Drawing II - Spring, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>51-132</td>
<td>Introduction to Photo Design - Spring, Freshman year</td>
<td>4.5</td>
</tr>
<tr>
<td>51-134</td>
<td>Photo Design II - Spring, Freshman year</td>
<td>4.5</td>
</tr>
<tr>
<td>51-171</td>
<td>Human Experience in Design - Fall, Sophomore year</td>
<td>4.5</td>
</tr>
<tr>
<td>51-241</td>
<td>How People Work - Fall, Sophomore year</td>
<td>9</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I - Fall, Sophomore year</td>
<td>9</td>
</tr>
<tr>
<td>60-200</td>
<td>Sophomore Review - Spring</td>
<td>0</td>
</tr>
<tr>
<td>60-400</td>
<td>Senior Review - Spring</td>
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<tr>
<td>S1-101</td>
<td>Design Studio I - Fall, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>S1-102</td>
<td>Design Studio II - Spring, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>S1-103</td>
<td>Design Workshop - Fall, Freshman year</td>
<td>3</td>
</tr>
<tr>
<td>S1-104</td>
<td>Design Workshop - Spring, Freshman year</td>
<td>4.5</td>
</tr>
<tr>
<td>S1-121</td>
<td>Design Drawing I - Fall, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>S1-122</td>
<td>Design Drawing II - Spring, Freshman year</td>
<td>9</td>
</tr>
<tr>
<td>S1-132</td>
<td>Introduction to Photo Design - Spring, Freshman year</td>
<td>4.5</td>
</tr>
<tr>
<td>S1-134</td>
<td>Photo Design II - Spring, Freshman year</td>
<td>4.5</td>
</tr>
<tr>
<td>S1-171</td>
<td>Human Experience in Design - Fall, Sophomore year</td>
<td>4.5</td>
</tr>
<tr>
<td>S1-241</td>
<td>How People Work - Fall, Sophomore year</td>
<td>9</td>
</tr>
<tr>
<td>S1-271</td>
<td>Design History I - Fall, Sophomore year</td>
<td>9</td>
</tr>
<tr>
<td>S1-201</td>
<td>CD I - Basic Type - Fall</td>
<td>9</td>
</tr>
<tr>
<td>S1-203</td>
<td>Communication Design Computer Lab - Fall</td>
<td>3</td>
</tr>
<tr>
<td>S1-229</td>
<td>Digital Photographic Imaging - Fall</td>
<td>9</td>
</tr>
<tr>
<td>51-151-51-152</td>
<td>Stagecraft and Stagecraft</td>
<td>26</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping</td>
<td>4.5</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping</td>
<td>4.5</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping</td>
<td>4.5</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Choose 9 additional Design units in consultation with the Design advisor.

**Industrial Design Required Courses (18 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-211</td>
<td>Generation of Form: Industrial Design</td>
<td>9</td>
</tr>
<tr>
<td>51-243</td>
<td>Prototyping</td>
<td>4.5</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Choose 12 additional Design units in consultation with the Design advisor.

**Drama Concentration (108 units minimum)**

AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY CONCENTRATION OPTION. PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTION.

Options available in the following areas: 1) Design, 2) Directing, 3) Dramaturgy, 4) Production Technology and Management.

**Required Courses for All Concentration Options (20 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-175-54-176</td>
<td>Conservatory Hour and Conservatory Hour (2 unit each)</td>
<td>2</td>
</tr>
<tr>
<td>54-177</td>
<td>Foundations of Drama I</td>
<td>6</td>
</tr>
<tr>
<td>54-178</td>
<td>Foundations of Drama II</td>
<td>6</td>
</tr>
<tr>
<td>54-281</td>
<td>Foundations of Drama II (prerequisite: 48-177 or 54-178)</td>
<td>6</td>
</tr>
<tr>
<td>54-381</td>
<td>Special Topics in Drama: History, Literature and Criticism</td>
<td>6</td>
</tr>
</tbody>
</table>

Work with Drama Advisor to Form Concentration Option (88 units minimum):

**Design Required Courses (26 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-151-54-152</td>
<td>Stagecraft and Stagecraft (35 units + 11 units)</td>
<td>26</td>
</tr>
</tbody>
</table>

Choose 62 additional Design units in consultation with the Design advisor.

**Directing Required Courses (49-52 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-121-54-122</td>
<td>Directing I: Sources and Directing II: Sources</td>
<td>18</td>
</tr>
<tr>
<td>54-221-54-222</td>
<td>Directing II: Fundamentals and Directing II: Fundamentals</td>
<td>15-18</td>
</tr>
<tr>
<td>54-159-54-160</td>
<td>Production Symposium I and Production Symposium I</td>
<td>12</td>
</tr>
<tr>
<td>54-317-54-318</td>
<td>Director's Colloquium and Director's Colloquium (four times, 4 units total)</td>
<td>2</td>
</tr>
</tbody>
</table>

Choose 36-39 additional Directing units in consultation with the Directing advisor.

**Dramaturgy Required Courses (53 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-109</td>
<td>Dramaturgy I: Approaches to Text</td>
<td>9</td>
</tr>
<tr>
<td>54-184</td>
<td>Dramaturgy 2: History and Practice</td>
<td>9</td>
</tr>
<tr>
<td>54-160</td>
<td>Production Symposium I - Spring</td>
<td>6</td>
</tr>
<tr>
<td>54-200</td>
<td>Ghost Light Forum</td>
<td>2</td>
</tr>
<tr>
<td>54-387</td>
<td>Dramaturgy : Production I</td>
<td>9</td>
</tr>
<tr>
<td>54-xxx</td>
<td>Dramaturgy 3, 4, 5 or 6 (take two in any order during the sophomore, junior, and senior years)</td>
<td>18</td>
</tr>
</tbody>
</table>

Choose 35 additional Dramaturgy units in consultation with the Dramaturgy advisor.

**Production Technology and Management Required Courses (26 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-151-54-152</td>
<td>Stagecraft and Stagecraft (35 units + 11 units)</td>
<td>26</td>
</tr>
</tbody>
</table>

Choose 62 additional PTM units in consultation with the PTM advisor.

**Music Concentration (108 units minimum)**

AUDITION REQUIRED FOR MUSIC PERFORMANCE CONCENTRATION OPTION. PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR MUSIC COMPOSITION, MUSICOLOGY AND CULTURAL STUDIES, OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music Performance (instrumental, piano, organ, voice), 2) Music Composition 3) Musicology and Cultural Studies, 4) Music Technology

The Musicology and Cultural Studies option and Music Technology option are available only to internal transfer students beginning fall '14.

**Required Course for All Concentration Options (9 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-152</td>
<td>Harmony I</td>
<td>9</td>
</tr>
</tbody>
</table>

**Music Performance and Music Composition Required Courses (76 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-161</td>
<td>Euphony I</td>
<td>3</td>
</tr>
<tr>
<td>57-162</td>
<td>Solfege I</td>
<td>3</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians (co-requisite: 51-173)</td>
<td>1</td>
</tr>
<tr>
<td>57-69x</td>
<td>BXA Studio (4 semesters)</td>
<td>36</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Major Ensemble (4 semesters)</td>
<td>24</td>
</tr>
</tbody>
</table>

Choose 23 additional Music units in consultation with the Music advisor.

**Musicology and Cultural Studies Required Courses (45 units)**
Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BSA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school.

Students choose their science concentration from among the four departments in MCS: Biological Sciences, Chemistry, Mathematical Sciences, or Physics.

The BSA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BXA Intercollege Degree Programs. The director and associate director/academic advisor of the BXA Intercollege Degree Programs are the primary advisors and liaisons between CFA and MCS. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA for their fine arts concentration, and an advisor in MCS for their natural sciences/mathematics concentration. This network of advisors guides each student through their curriculum.

BSA Curriculum

I. BSA Core
(16 courses, 135 units minimum)
- Writing/Expression (1 course, 9 units, 76-101 required)
- Cultural Analysis (1 course, 9 units minimum)
- Economic, Political, & Social Institutions OR Cognition, Choice & Behavior (1 course, 9 units minimum)
- Two additional courses from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology (2 courses, 18 units minimum)
- Mathematics (2 courses, 20 units, 21-120 and 21-122 required)
- Science (3 courses, 31 units, 03-121, 09-105, and 33-111 required)
- BXA Freshman Research Seminar (1 course, 9 units, 62-190 required)
- BXA Junior Seminar (1 course, 9 units, 62-410 required)
- BXA Junior Portfolio Review (complete 1 required review, 0 units, 62-391 required)
- BXA Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, required in first semester)

Writing/Expression (1 course, 9 units)
- Broadly considered, language is a tool used to communicate, as well as a way to organize non-visual and non-mathematical thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

Cultural Analysis (1 course, complete 9 units minimum)
This category explores definitions of culture and the role culture plays in producing different actions and institutions as well as the roles of institutions, systems and human actions in shaping cultural contexts. Listed below are examples of courses that meet the requirement for this category.

Bachelor of Science and Arts Degree Program
Carnegie Mellon University recognizes that there are students who are naturally gifted in both the fine arts and the natural sciences or mathematics. In order to accommodate students who want to pursue an education simultaneously in these areas, we offer a degree that combines the strengths of the College of Fine Arts (CFA) and the Mellon College of Science (MCS). The intercollege degree, called the Bachelor of Science and Arts (BSA), is a rigorous program that offers a unique group of qualified students the opportunity to develop their talents and interests in an area of the fine arts and an area of the natural sciences or mathematics.

The BSA curriculum is divided into three parts: 1) BSA Core requirements, 2) CFA concentration coursework, and 3) MCS concentration coursework.
Economic, Political & Social Institutions OR Cognition, Choice, and Behavior (1 course from either category, complete 9 units minimum)

Economic, Political & Social Institutions

This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

Cognition, Choice, and Behavior

This category uses model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

* Indicates co-requisites and/or prerequisites required.
BXA Capstone Project (2 courses, 18 units)

The BXA Capstone Project gives BXA students the opportunity to demonstrate the extent of their interdisciplinary work over the course of their academic career. The Capstone Project should include elements that span the student’s CFA and DC concentrations (for BSA students), CFA and MCS concentrations (for BXA students), or CFA and SCS concentrations (for BCSA students). The project can be either a scholarly or creative endeavor, and may take one of many possible forms (e.g., a written thesis, a compilation of creative work or works, an experiment and report, a computer program or animation, etc.).

The BXA Capstone sequence covers both semesters of a student’s senior year. In the fall, students are enrolled in 62-401 BXA Capstone Project I (9 units), which meets weekly to discuss strategies for managing research, planning the project, and larger theoretical issues related to interdisciplinary work. At the end of the fall course, students will have produced a Capstone Project proposal, an annotated bibliography, and multiple versions of their project pitch. In the spring, students enroll in 62-402 BXA Capstone Project II (9 units), which has no required classroom time. Instead, students spend the semester doing the research and foundational work necessary for the project, as well as meeting with their faculty and BXA advisors as they create their Capstone Project and prepare to present it at the annual Meeting of the Minds Undergraduate Research Symposium held each May.

Computing @ Carnegie Mellon (1 mini-course, 3 units)

This is a mini-course, pass/no pass, to be completed in the first semester.

II. MCS Concentration

(number of courses vary, 120-134 units)

BSA students choose one of the following concentrations:
- Biological Sciences (120 units)
- Chemistry (124 units)
- Mathematical Sciences (122 units)
- Physics (134 units)

Biological Sciences Concentration (120 units minimum)

Biological Sciences Required Courses (102 units minimum)

03-231 Biochemistry I 9
or 03-232 Biochemistry I 9
03-240 Cell Biology 9
03-330 Genetics 9
03-124 Modern Biology Laboratory 9
or 03-343 Experimental Techniques in Molecular Biology 9
03-201/202 Undergraduate Colloquium for Sophomores 2
09-106 Modern Chemistry II 10
09-217 Organic Chemistry I 9
09-218 Organic Chemistry II 9
09-221 Laboratory I: Introduction to Chemical Analysis 12
09-222 Laboratory II: Organic Synthesis and Analysis 12
33-112 Physics II for Science Students 12

Advanced Biological Sciences Electives (2 courses, 18 units)

Must be selected from 03-3xx, excluding 03-445.

Chemistry Concentration (124 units minimum)

Chemistry Required Courses (106 units)

09-106 Modern Chemistry II 10
09-219 Modern Organic Chemistry 10
09-220 Modern Organic Chemistry II 10
09-214 Physical Chemistry 9
or 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry 9
or 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry 9
09-348 Inorganic Chemistry 10
09-221 Laboratory I: Introduction to Chemical Analysis 12
09-222 Laboratory II: Organic Synthesis and Analysis 12
09-321 Laboratory III: Molecular Design and Synthesis 12
09-204 Professional Communication Skills in Chemistry 3

Advanced Chemistry Electives (2 courses, 18 units)

May be any upper level chemistry course, 09-3xx or higher, or Biochemistry I, 09-231 or 09-232, with the exception of 09-435 Independent Study, which can be used only by permission of the Director of Undergraduate Studies.

Mathematical Sciences Concentration (122 units minimum)

Mathematical Sciences Required Courses (86 units minimum)

(Reasonable substitutions within the core program will be allowed.)

15-110 Principles of Computing 10
21-127 Concepts of Mathematics (prerequisite for 15-211) 10
21-228 Discrete Mathematics 9
21-241 Matrices and Linear Transformations (or 21-341 Linear Algebra) 10
21-259 Calculus in Three Dimensions 9
21-260 Differential Equations 9
21-355 Principles of Real Analysis I 9
21-373 Algebraic Structures 9
33-112 Physics I for Science Students 12

Mathematical Sciences Electives (2 courses, 18 units)

Students with a music focus should take 21-372 Partial Differential Equations.

Mathematical Sciences, Statistics, or Computer Science Electives (2 courses, 18 units)

May be computer science course above the 100-level, mathematical science courses beyond the calculus sequence, and statistics courses at the level of 36-225 or higher.

Physics Concentration (134 units minimum)

Physics Required Courses (116 units)

21-259 Calculus in Three Dimensions 9
33-104 Experimental Physics 9
33-112 Physics I for Science Students 12
33-201 Physics Sophomore Colloquium I - Fall 2
33-202 Physics Sophomore Colloquium II - Spring 2
33-211 Physics II: Modern Essentials 10
33-228 Electronics I 10
33-231 Physical Analysis 10
33-232 Mathematical Methods of Physics 10
33-234 Quantum Physics 10
33-301 Physics Upperclass Colloquium I - Fall 1
33-302 Physics Upperclass Colloquium II - Spring 1
33-311 Physical Mechanics I 10
33-338 Intermediate Electricity and Magnetism I 10
33-340 Modern Physics Laboratory 10
33-341 Thermal Physics I 10

Physics Electives (2 courses, 18 units)

Two courses to be pre-approved by the Physics Department.

NOTE: 33-114 Physics of Musical Sound (9 units) is highly recommended for students with a Music concentration.

III. College of Fine Arts Concentration

(number of courses vary, 108 units minimum)

BSA students choose one of the following concentrations:
- Architecture (108 units)
- Art (108 units)
- Design (108 units)
- Drama (108 units)
- Music (108 units)

Architecture Concentration (108 units minimum)

Architecture Required Courses (54 units minimum)

48-100 Architecture Design Studio: Foundation I - Fall 12
or 48-095 Spatial Concepts for Non-Architects I 12
48-130 Architectural Drawing I: A Textile Foundation - Fall 9
48-135 Architectural Drawing II: Appearance - Spring 9
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title and Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-240</td>
<td>Historical Survey of World Architecture and Urbanism I -Spring 9</td>
</tr>
<tr>
<td>48-zzz</td>
<td>Architectural History Lecture (varying topics) 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History Lecture (varying topics) 9</td>
</tr>
</tbody>
</table>

**Work with Architecture Advisor to Form Concentration. Please review the following suggested curricula areas of Elective Focus. (54 units minimum):**

**Elective Focus: General Education in Architecture (54 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statics (prerequisite: 33-106 or 48-116) -Fall 9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 12-235 or 48-210) -Spring 9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 48-207 or 48-210) -Spring 9</td>
</tr>
<tr>
<td>48-3xx</td>
<td>Drawing Elective 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History Lecture (varying topics) 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History Lecture (varying topics) 9</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural Representation and Visualization (57 units)**

This sequence is intended to develop particular skills in architectural representation.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-120</td>
<td>Introduction to Digital Media I -Fall 6</td>
</tr>
<tr>
<td>48-125</td>
<td>Introduction to Digital Media II (prerequisite: 48-120) -Spring 6</td>
</tr>
<tr>
<td>48-3xx</td>
<td>Drawing Elective 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Undergraduate Representation/Visualization Elective (pre-approval of coursework required) 18</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Graduate Representation/Visualization Elective (pre-approval of coursework required) 18</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural Technology (54 units)**

This sequence is intended to develop intellectual links to the technical aspects of the profession.

**Prerequisite Courses:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-116</td>
<td>Building Physics 9</td>
</tr>
<tr>
<td>60-175</td>
<td>Descriptive Geometry 6</td>
</tr>
</tbody>
</table>

**Elective Courses:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statics (prerequisite: 33-106 or 48-116) -Fall 9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 12-235 or 48-210) -Spring 9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 12-207 or 48-210) -Spring 9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate &amp; Energy (prerequisite: 33-106 or 48-116) -Fall 9</td>
</tr>
<tr>
<td>48-412</td>
<td>Environment II: Mechanical Systems (prerequisite: 48-105) -Fall 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Designated Departmental Technical Elective 9</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural History (six varying topics, 54 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-zxx</td>
<td>Architectural History 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History 9</td>
</tr>
<tr>
<td>48-zxx</td>
<td>Architectural History 9</td>
</tr>
</tbody>
</table>

**Art Concentration (108 units minimum)**

**PORTFOLIO REVIEW REQUIRED FOR ADMISSION**

**Concept Studios (2 courses, 20 units)**

Complete two courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-101</td>
<td>Concept Studio I 10</td>
</tr>
<tr>
<td>60-201</td>
<td>Concept Studio II 10</td>
</tr>
<tr>
<td>60-202</td>
<td>Concept Studio III 10</td>
</tr>
<tr>
<td>60-203</td>
<td>Concept Studio: EOLAT 10</td>
</tr>
<tr>
<td>60-204</td>
<td>Concept Studio: Networked Narrative 10</td>
</tr>
</tbody>
</table>

**Media Studios (3 courses, 30 units)**

Complete three courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-150</td>
<td>2D Media Studio: Drawing 10</td>
</tr>
<tr>
<td>60-160</td>
<td>2D Media Studio: Imaging 10</td>
</tr>
<tr>
<td>60-250</td>
<td>2D Media Studio: Painting 10</td>
</tr>
<tr>
<td>60-251</td>
<td>2D Media Studio: Print Media 10</td>
</tr>
<tr>
<td>60-130-60-130</td>
<td>3D Media Studio 1-3 and 3D Media Studio I (complete two minis, 5 units each) 10</td>
</tr>
<tr>
<td>60-131-60-131</td>
<td>3D Media Studio II and 3D Media Studio II (complete two minis, 5 units each) 10</td>
</tr>
<tr>
<td>60-110</td>
<td>Electronic Media Studio I 10</td>
</tr>
<tr>
<td>60-210</td>
<td>Electronic Media Studio II 10</td>
</tr>
</tbody>
</table>

**Advanced Studios (4 courses, 40 units)**

Complete four courses. Courses may be offered in the fall and/or spring. Students may take courses in any media area (ETB, SIS, CP or DP3). They may take all courses in one media area if a focus is desired.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-410</td>
<td>Advanced Electronic and Time-Based Work (ETB) 10</td>
</tr>
<tr>
<td>60-430</td>
<td>Advanced Electronic and Time-Based Work (ETB) 10</td>
</tr>
<tr>
<td>60-448</td>
<td>Advanced Contextual Practice (CP) 10</td>
</tr>
<tr>
<td>60-450</td>
<td>Advanced Drawing, Painting, Print Media and Photography (DP3) 10</td>
</tr>
<tr>
<td>60-499</td>
<td>Studio Independent Study (one only) 10</td>
</tr>
</tbody>
</table>

**Art History/Theory (2 courses, 18 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-205</td>
<td>Modern Visual Culture 1789-1945 9</td>
</tr>
<tr>
<td>60-206</td>
<td>Contemporary Visual Culture from 1945 to the Present 9</td>
</tr>
</tbody>
</table>

**Review Requirement** (Complete 2 required reviews, 0 units)

A review is required at the end of the sophomore and senior years. Pass/no pass only.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-200</td>
<td>Sophomore Review -Spring 0</td>
</tr>
<tr>
<td>60-400</td>
<td>Senior Review -Spring 0</td>
</tr>
</tbody>
</table>

**Design Concentration (108 units minimum)**

**PORTFOLIO REVIEW REQUIRED FOR ADMISSION**

Options available in the following areas, to be selected in the sophomore year:

1. Communication Design, 2. Industrial Design

**Required Courses for Both Options (78 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-101</td>
<td>Design Studio I -Fall, Freshman year 9</td>
</tr>
<tr>
<td>51-102</td>
<td>Design Studio II -Spring, Freshman year 9</td>
</tr>
<tr>
<td>51-103</td>
<td>Design Workshop -Fall, Freshman year 3</td>
</tr>
<tr>
<td>51-104</td>
<td>Design Workshop II -Spring, Freshman year 3</td>
</tr>
<tr>
<td>51-121</td>
<td>Design Drawing I -Fall, Freshman year 9</td>
</tr>
<tr>
<td>51-122</td>
<td>Design Drawing II -Spring, Freshman year 9</td>
</tr>
<tr>
<td>51-132</td>
<td>Introduction to Photo Design -Spring, Freshman year 4.5</td>
</tr>
<tr>
<td>51-134</td>
<td>Photo Design I -Spring, Freshman year 4.5</td>
</tr>
<tr>
<td>51-171</td>
<td>Human Experience in Design -Fall, Sophomore year 9</td>
</tr>
<tr>
<td>51-241</td>
<td>How People Work -Fall, Sophomore year 9</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I -Fall, Sophomore year 9</td>
</tr>
</tbody>
</table>

**Work with Design Advisor in the Sophomore Year to Form Concentration Option**

(30 units minimum):

**Communication Design Required Courses (21 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-201</td>
<td>CD I: Basic Type -Fall 9</td>
</tr>
<tr>
<td>51-203</td>
<td>Communication Design Computer Lab -Fall 9</td>
</tr>
<tr>
<td>51-299</td>
<td>Digital Photographic Imaging -Fall 9</td>
</tr>
</tbody>
</table>

Choose 9 additional Design units in consultation with the Design advisor.

**Industrial Design Required Courses (18 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-211</td>
<td>Generation of Form: Industrial Design I 9</td>
</tr>
<tr>
<td>51-243</td>
<td>Prototyping 4.5</td>
</tr>
<tr>
<td>51-251</td>
<td>Digital Prototyping 4.5</td>
</tr>
</tbody>
</table>

Choose 12 additional Design units in consultation with the Design advisor.

**Drama Concentration (108 units minimum)**

**AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY CONCENTRATION OPTION. PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTION.**

Options available in the following areas: 1) Design, 2) Directing, 3) Dramaturgy, 4) Production Technology and Management

There is no BSA Acting or Musical Theatre option.

**Required Courses for All Concentration Options (20 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-175-54-176</td>
<td>Conservatory Hour and Conservatory Hour (1 unit each) 2</td>
</tr>
<tr>
<td>54-277</td>
<td>Foundations of Drama I 6</td>
</tr>
<tr>
<td>54-178</td>
<td>Foundations of Drama I 6</td>
</tr>
<tr>
<td>54-281</td>
<td>Foundations of Drama II (prerequisite: 54-177 or 54-178) 6</td>
</tr>
<tr>
<td>54-282</td>
<td>Foundations of Drama II 6</td>
</tr>
<tr>
<td>54-381</td>
<td>Special Topics in Drama: History, Literature and Criticism 6</td>
</tr>
</tbody>
</table>

**Work with Drama Advisor to Form Concentration Option** (88 units minimum):

**Design Required Courses (26 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-151-54-152</td>
<td>Stagescript and Stagescript (15 units + 11 units) 26</td>
</tr>
</tbody>
</table>
Choose 62 additional Design units in consultation with the Design advisor.

Directing Required Courses (49-52 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-121-54-122</td>
<td>Directing I: Sources and Directing I: Sources</td>
<td>18</td>
</tr>
<tr>
<td>54-221-54-222</td>
<td>Directing II: Fundamentals and Directing II: Fundamentals (6 or 9 units + 9 units)</td>
<td>18</td>
</tr>
<tr>
<td>54-159-54-160</td>
<td>Production Symposium I and Production Symposium I</td>
<td>12</td>
</tr>
<tr>
<td>54-537-54-538</td>
<td>Director's Colloquium and Director's Colloquium (four times, 4 units total)</td>
<td>2</td>
</tr>
</tbody>
</table>

Choose 36-39 additional Directing units in consultation with the Directing advisor.

Dramaturgy Required Courses (53 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-109</td>
<td>Dramaturgy 1: Approaches to Text</td>
<td>9</td>
</tr>
<tr>
<td>54-184</td>
<td>Dramaturgy 2: History and Practice</td>
<td>9</td>
</tr>
<tr>
<td>54-160</td>
<td>Production Symposium I and Spring</td>
<td>6</td>
</tr>
<tr>
<td>54-200</td>
<td>Ghost Light Forum (two times, 2 units total) - Fall</td>
<td>1</td>
</tr>
<tr>
<td>54-387</td>
<td>Dramaturgy: Production I</td>
<td>9</td>
</tr>
<tr>
<td>54-xxx</td>
<td>Dramaturgy 3, 4, 5 or 6 (take two in any order during the sophomore, junior, and senior years)</td>
<td>18</td>
</tr>
</tbody>
</table>

Choose 35 additional Dramaturgy units in consultation with the Dramaturgy advisor.

Production Technology and Management Required Courses (26 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-151-54-152</td>
<td>Stagecraft and Stagecraft (15 units)</td>
<td>26</td>
</tr>
</tbody>
</table>

Choose 62 additional PTM units in consultation with the PTM advisor.

Music Concentration (108 units minimum)

AUDITION REQUIRED FOR MUSIC PERFORMANCE CONCENTRATION OPTION. PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR MUSIC COMPOSITION, MUSICOCOLOGY AND CULTURAL STUDIES, OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music Performance (instrumental, piano, organ, voice), 2) Music Composition 3) Musicology and Cultural Studies, 4) Music Technology

The Musicology and Cultural Studies option and Music Technology option are available only to internal transfer students beginning fall '14.

Required Course for All Concentration Options (9 units)

57-152 | Harmony I | 9     |

Music Performance and Music Composition Required Courses (76 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-161</td>
<td>Eurhythmics I</td>
<td>3</td>
</tr>
<tr>
<td>57-181</td>
<td>Solfege I</td>
<td>3</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians (co-requisite: 57-173)</td>
<td>1</td>
</tr>
<tr>
<td>57-69x</td>
<td>BXA Studio (4 semesters)</td>
<td>36</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Major Ensemble (4 semesters)</td>
<td>24</td>
</tr>
</tbody>
</table>

Choose 23 additional Music units in consultation with the Music advisor.

Musicology and Cultural Studies Required Courses (45 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-283</td>
<td>Music History I</td>
<td>9</td>
</tr>
<tr>
<td>57-284</td>
<td>Music History II</td>
<td>9</td>
</tr>
<tr>
<td>57-285</td>
<td>Music History III</td>
<td>9</td>
</tr>
<tr>
<td>57-289</td>
<td>Introduction to Repertoire and Listening for Musicians I</td>
<td>3</td>
</tr>
<tr>
<td>57-190</td>
<td>Repertoire and Listening for Musicians I (co-requisite: 57-283)</td>
<td>3</td>
</tr>
<tr>
<td>57-289</td>
<td>Repertoire and Listening for Musicians II (co-requisite: 57-284)</td>
<td>3</td>
</tr>
<tr>
<td>57-290</td>
<td>Repertoire and Listening for Musicians III (co-requisite: 57-285)</td>
<td>3</td>
</tr>
<tr>
<td>57-611</td>
<td>Independent Study in History</td>
<td>6</td>
</tr>
</tbody>
</table>

Choose 36 units from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-209</td>
<td>The Beatles</td>
<td>9</td>
</tr>
<tr>
<td>57-306</td>
<td>World Music</td>
<td>6</td>
</tr>
<tr>
<td>57-377</td>
<td>Psychology of Music</td>
<td>9</td>
</tr>
<tr>
<td>57-412</td>
<td>Opera Since Wagner</td>
<td>9</td>
</tr>
<tr>
<td>57-414</td>
<td>Music and Nature</td>
<td>9</td>
</tr>
<tr>
<td>57-415</td>
<td>Mozart Operas</td>
<td>3</td>
</tr>
<tr>
<td>57-477</td>
<td>Music of the Spirit</td>
<td>6</td>
</tr>
<tr>
<td>57-478</td>
<td>Survey of Historical Recording</td>
<td>6</td>
</tr>
<tr>
<td>57-480</td>
<td>History of Black American Music</td>
<td>6</td>
</tr>
</tbody>
</table>

Graduate Musicology courses may be taken with instructor permission.

Choose 18 additional Music units in consultation with the Music advisor.

Music Technology Required Courses (40 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-101</td>
<td>Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-185</td>
<td>Solfege</td>
<td>3</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians (co-requisite: 57-173)</td>
<td>1</td>
</tr>
<tr>
<td>57-337</td>
<td>Sound Recording</td>
<td>6</td>
</tr>
<tr>
<td>57-347</td>
<td>Electronic and Computer Music</td>
<td>6</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Independent Study in Music Technology or Sound Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose 36 units from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-153</td>
<td>Harmony II</td>
<td>9</td>
</tr>
<tr>
<td>57-182</td>
<td>Solfege</td>
<td>3</td>
</tr>
<tr>
<td>57-283</td>
<td>Music History I</td>
<td>9</td>
</tr>
<tr>
<td>57-284</td>
<td>Music History II</td>
<td>9</td>
</tr>
<tr>
<td>57-285</td>
<td>Music History III</td>
<td>9</td>
</tr>
<tr>
<td>57-190</td>
<td>Repertoire and Listening for Musicians I (co-requisite: 57-283)</td>
<td>3</td>
</tr>
<tr>
<td>57-289</td>
<td>Repertoire and Listening for Musicians II (co-requisite: 57-284)</td>
<td>3</td>
</tr>
<tr>
<td>57-290</td>
<td>Repertoire and Listening for Musicians III (co-requisite: 57-285)</td>
<td>3</td>
</tr>
<tr>
<td>57-338</td>
<td>Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose 23 additional Music units in consultation with the Music advisor.

IV. Free Electives

(approximately 1-2 courses, 3-17 units)

Take any Carnegie Mellon course. A maximum of 9 units of physical education and/or military science may be counted toward this requirement. Physical education and military science courses will not be calculated in a student’s QPA.

Bachelor of Computer Science and Arts Degree Program

Carnegie Mellon University recognizes that there are students who are naturally gifted in both the fine arts and computer science. In order to accommodate students who want to pursue an education simultaneously in these areas, we offer a degree that combines the strengths of the College of Fine Arts (CFA) and the School of Computer Science (SCS). The intercollege degree, called the Bachelor of Computer Science and Arts (BCSA), is a rigorous program that offers a unique group of qualified students the opportunity to develop their talents and interests in an area of the fine arts and computer science.

The BCSA curriculum is divided into three parts: 1) BCSA Core requirements, 2) CFA concentration coursework; and 3) SCS concentration coursework.

Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BCSA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school.

The BCSA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BXA Intercollege Degree Programs. The director and associate director/academic advisor of the BXA Intercollege Degree Programs are the primary advisors and liaisons between CFA and SCS. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA and a student advisor in computer science. This network of advisors guides each student through their curriculum.

BCSA Curriculum

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. BCSA Core</td>
<td>121</td>
</tr>
<tr>
<td>II. SCS Concentration</td>
<td>112</td>
</tr>
<tr>
<td>III. CFA Concentration</td>
<td>108-118</td>
</tr>
<tr>
<td>IV. BCSA Free Electives</td>
<td>29-39</td>
</tr>
<tr>
<td>Total BCSA Degree Requirements</td>
<td>380</td>
</tr>
</tbody>
</table>
I. BCSA Core
(15 courses, 121 units minimum)

- Writing/Expression (1 course, 9 units, 76-101 required)
- Cultural Analysis (1 course, 9 units minimum)
- Mathematics (2 courses, 19 units minimum, 21-120 and 21-122, or 21-241 required, Probability (1 course, 9 units minimum required)
- Science (2 courses, 18 units minimum)
- Engineering (in consultation with your academic advisor, an engineering course could substitute for one of the two science requirements)
- Economic, Political, & Social Institutions OR Cognition, Choice & Behavior (1 course, 9 units minimum)
- One additional course from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology (1 course, 9 units minimum)
- BXA Freshman Research Seminar (1 course, 9 units, 62-190 required)
- BXA Junior Seminar (1 course, 9 units, 62-410 required)
- BXA Junior Portfolio Review (complete 1 required review, 0 units, 62-391 required)
- BXA Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, required in first semester)

Writing/Expression (1 course, 9 units)

Broadly considered, language is a tool used to communicate, as well as a way to organize non-visual and non-mathematical thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

Cultural Analysis (1 course, complete 9 units minimum)

This category explores definitions of culture and the role culture plays in producing different actions and institutions as well as the roles of institutions, systems and human actions in shaping cultural contexts. Listed below are examples of courses that meet the requirement for this category.

Mathematics & Probability (3 courses, 29 units minimum)

Choose two mathematics courses (20 units minimum):

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
- 21-241 Linear Algebra and Linear Transformations

Choose one probability course (9 units minimum):

- 36-359 Probability and Computing
- 36-325 Probability
- 36-217 Probability Theory and Random Processes
- 36-225 Introduction to Probability Theory
- 36-625 Probability and Mathematical Statistics I

Science (2 courses, 18 units minimum)

Choose two courses from the following list:

- 03-121 Modern Biology
- 09-105 Introduction to Modern Chemistry I
- 21-259 Calculus in Three Dimensions
- 33-111 Physics I for Science Students

Engineering

In consultation with your academic advisor, an engineering course could substitute for one of the two science requirements.

Economic, Political & Social Institutions OR Cognition, Choice & Behavior (1 course from either category, complete 9 units minimum)

Economic, Political & Social Institutions

This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

Cognition, Choice, and Behavior

This category use model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

Complete ONE additional course from one of the following departments (1 course, complete 9 units minimum)

- English
- History
- Modern Languages
- Philosophy
- Psychology

BXA Freshman Research Seminar (1 course, 9 units)

Section B of the BXA Freshman Research Seminar introduces first-year students to the field of interdisciplinary work and arts-based research. Students engage with theoretical and practical readings from across the
various concentrations, with particular emphasis on aesthetic theory. Guest lectures complement the weekly readings by giving insight into practical implementations of these ideas. Students will conceive, research, and create a final project to be presented at the end of the semester.

Section A of the BXA Research Freshman Seminar has been designed for internal transfer students only and it is offered in the fall and spring semesters. Using the arts as primary modes of inquiry, this course’s content probes the idiosyncratic field of arts-based research by following the principle that there is no aspect of human life that cannot be studied objectively, quantified and analyzed. Aside from discussing a digest of the latest writings on arts-based research, students will try their own approach to arts-based research by building prismatic artistic and literary constructs inspired by the reading of Italo Calvino’s Six Memos for the Next Millennium, Cosmicomics, and Invisible Cities.

II. SCS Concentration
School of Computer Science Concentration (112 units minimum)

Prerequisite

15-112 Fundamentals of Programming and Computer Science 12

Computer Science Core Requirements (57 units)

15-122 Principles of Imperative Computation 10
15-128 Freshman Immigration Course 1
15-150 Principles of Functional Programming 10
15-210 Parallel and Sequential Data Structures and Algorithms 12
15-213 Introduction to Computer Systems 12
15-251 Great Theoretical Ideas in Computer Science 12

Concepts of Mathematics (10 units)

21-127 Concepts of Mathematics (co-requisite for 15-122; prerequisite for 15-150) 10

Applications Courses or CS Electives (5 courses, 45 units minimum)

Consult with the CS advisor to choose a minimum of five courses from the following list:

11-411 Natural Language Processing 12
15-313 Foundations of Software Engineering 12
15-322 Introduction to Computer Music 9
15-323 Computer Networks and Information Processing 9
15-381 Artificial Intelligence: Representation and Problem Solving 9
15-385 Computer Vision 9
15-415 Database Applications 12
15-437 Web Application Development 12
15-451 Algorithm Design and Analysis 12
15-462 Computer Graphics 12
15-463 Computational Photography 12
15-464 Technical Animation 12
15-465 Animation Art and Technology 12
15-466 Computer Game Programming 12
16-362 Mobile Robot Programming Laboratory 12
16-384 Robot Kinematics and Dynamics 12

Others as appropriate with advisor’s permission.

III. College of Fine Arts Concentration
(number of courses vary, 108-118 units minimum)

BCSA students choose one of the following concentrations:

• Architecture (108 units)
• Art (118 units)
• Design (108 units)
• Drama (108 units)
• Music (108 units)

Architecture Concentration (108 units minimum)

Architecture Required Courses (54 units minimum)

48-100 Architecture Design Studio: Foundation I - Fall 12
or 48-095 Spatial Concepts for Non-Architects I
48-130 Architectural Drawing I: A. Tectonic Foundation - Fall 9
48-135 Architectural Drawing II: Appearance - Spring 9
48-240 Historical Survey of World Architecture and Urbanism I - Spring 9
48-xxx Architectural History Lecture (varying topics) 9
48-xxx Architectural History Lecture (varying topics) 9

Work with Architecture Advisor to Form Concentration. Please Review the Following Suggested Curricula Areas of Elective Focus. (54 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-210 Statics (prerequisite: 33-106 or 48-116) - Fall 9
48-215 Materials and Assembly (prerequisite: 12-235 or 48-210) - Spring 9
48-217 Structures (prerequisite: 48-207 or 48-210) - Spring 9
### Elective Focus: Architectural Representation and Visualization (57 units)

This sequence is intended to develop particular skills in architectural representation.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-120</td>
<td>Introduction to Digital Media I - Fall</td>
<td>6</td>
</tr>
<tr>
<td>48-125</td>
<td>Introduction to Digital Media II (prerequisite: 48-120) - Spring</td>
<td>6</td>
</tr>
<tr>
<td>48-3xx</td>
<td>Drawing Elective</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
</tbody>
</table>

### Elective Focus: Architectural Technology (54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-116</td>
<td>Building Physics</td>
<td>9</td>
</tr>
<tr>
<td>62-175</td>
<td>Descriptive Geometry</td>
<td>6</td>
</tr>
</tbody>
</table>

### Elective Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statics (prerequisite: 33-106 or 48-126) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly</td>
<td>9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 12-235 or 48-220) - Spring</td>
<td>9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate &amp; Energy (prerequisite: 33-106 or 48-126) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-412</td>
<td>Environment II: Mechanical Systems (prerequisite: 48-105) - Fall</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Designated Departmental Technical Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

### Elective Focus: Architectural History (six varying topics, 54 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-xxxx</td>
<td>Architectural History</td>
<td>9</td>
</tr>
</tbody>
</table>

### Art Concentration (118 units minimum)

#### PORTFOLIO REVIEW REQUIRED FOR ADMISSION

**Concept Studies** (2 courses, 20 units)

Complete two courses:

- 60-101 Concept Studio I
- 60-102 Concept Studio II
- 60-203 Concept Studio: Essay
- 60-204 Concept Studio: Networked Narrative

**Media Studios** (2 courses, 20 units)

Complete two courses:

- 60-150 2D Media Studio: Drawing
- 60-160 2D Media Studio: Imaging
- 60-250 2D Media Studio: Painting
- 60-251 2D Media Studio: Print Media
- 60-130-60-130 3D Media Studio I and 3D Media Studio I (complete two minis, 5 units each)
- 60-131-60-131 3D Media Studio I and 3D Media Studio II (complete two minis, 5 units each)
- 60-110 Electronic Media Studio I
- 60-210 Electronic Media Studio II

**Advanced Studios** (6 courses, 60 units)

Complete six courses. Courses may be offered in the fall and/or spring.

Students may take courses in any media area (ETB, SIS, CP or DP3). They may take all courses in one media area if a focus is desired.

- 60-410 - 60-429 Advanced Electronic and Time-Based Work (ETB)
- 60-430 - 60-447 Advancing Sculpture, Installation and Site-Work (SIS)
- 60-448 - 60-449 Advanced Conceptual Practice (CP)
- 60-450 - 60-498 Advanced Drawing, Painting, Print Media and Photography (PDP)
- 60-499 Studio Independent Study (one only)

**Art History/Theory** (2 courses, 18 units)

- 60-205 Modern Visual Culture 1879-1945
- 60-206 Contemporary Visual Culture from 1945 to the Present

**Review Requirement** (Complete 2 required reviews, 0 units)

A review is required at the end of the sophomore and senior years. Pass/no pass only.

- 60-200 Sophomore Review - Spring
- 60-400 Senior Review - Spring

### Design Concentration (108 units minimum)

**PORTFOLIO REVIEW REQUIRED FOR ADMISSION**

Options available in the following areas, to be selected in the sophomore year:

1) Communication Design, 2) Industrial Design

**Required Courses for Both Concentration Options (78 units)**

- 51-101 Design Studio I - Fall, Freshman year
- 51-102 Design Studio II - Spring, Freshman year
- 51-103 Design Workshop - Fall, Freshman year
- 51-104 Design Workshop II - Spring, Freshman year
- 51-121 Design Drawing I - Fall, Freshman year
- 51-122 Design Drawing II - Spring, Freshman year
- 51-132 Introduction to Photo Design - Spring, Freshman year 4.5
- 51-134 Photo Design II - Spring, Freshman year 4.5
- 51-171 Human Experience in Design - Fall, Sophomore year 9
- 51-241 How People Work - Fall, Sophomore year 9
- 51-271 Design History I - Fall, Sophomore year 9

Work with Design Advisor in the Sophomore Year to Form Concentration Option (30 units minimum):

**Communication Design Required Courses (21 units)**

- 51-201 CD I: Basic Type - Fall
- 51-203 Communication Design Computer Lab - Fall 3
- 51-229 Digital Photographic Imaging - Fall 9

Choose 9 additional Design units in consultation with the Design advisor.

**Industrial Design Required Courses (18 units)**

- 51-211 Generation of Form: Industrial Design I 9
- 51-243 Prototyping 4.5
- 51-251 Digital Prototyping 4.5

Choose 12 additional Design units in consultation with the Design advisor.

**Drama Concentration (108 units minimum)**

**AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY CONCENTRATION OPTION. PORTFOLIO REVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTION.**

Options available in the following areas: 1) Design, 2) Directing, 3) Dramaturgy, 4) Production Technology and Management

There is no BHA Acting or Musical Theatre option.

**Required Courses for All Concentration Options (20 units)**

- 54-175-54-176 Conservatory Hour and Conservatory Hour (1 unit each)
- 54-177 Foundations of Drama I or 54-178 Foundations of Drama I
- 54-281 Foundations of Drama II (prerequisite: 54-177 or 54-178)
- 54-282 Foundations of Drama II
- 54-381 Special Topics in Drama: History, Literature and Criticism 6

Work with Drama Advisor to Form Concentration Option (88 units minimum): **Design Required Courses (26 units)**

- 54-151-54-152 Stagecraft and Stagecraft (15 units + 11 units)

Choose 62 additional Design units in consultation with the Design advisor.

**Directing Required Courses (49-52 units)**

- 54-121-54-122 Directing I: Sources and Directing I: Sources
- 54-221-54-222 Directing II: Fundamentals and Directing II: Fundamentals (6 or 9 units = 9 units)
- 54-159-54-160 Production Symposium I and Production Symposium I
- 54-517-54-518 Director's Colloquium and Director's Colloquium (four times, 4 units total) 2
Choose 36-39 additional Directing units in consultation with the Directing advisor.

**Dramaturgy Required Courses (53 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-109</td>
<td>Dramaturgy I: Approaches to Text</td>
<td>9</td>
</tr>
<tr>
<td>54-184</td>
<td>Dramaturgy II: History and Practice</td>
<td>9</td>
</tr>
<tr>
<td>54-160</td>
<td>Production Symposium I - Spring</td>
<td>6</td>
</tr>
<tr>
<td>54-200</td>
<td>Ghost Light Forum (two times, 2 units total) - Fall</td>
<td>1</td>
</tr>
<tr>
<td>54-387</td>
<td>Dramaturgy III: Production I</td>
<td>9</td>
</tr>
<tr>
<td>54-xxx</td>
<td>Dramaturgy 3, 4, 5 or 6 (take two in any order during the sophomore, junior, and senior years)</td>
<td>18</td>
</tr>
</tbody>
</table>

Choose 35 additional Dramaturgy units in consultation with the Dramaturgy advisor.

**Production Technology and Management Required Courses (26 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-151-54-152</td>
<td>Stagecraft and Stagecraft (15 units + 11 units)</td>
<td>26</td>
</tr>
</tbody>
</table>

Choose 62 additional PTM units in consultation with the PTM advisor.

**Music Concentration (108 units minimum)**

PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR MUSIC COMPOSITION OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music Composition, 2) Music Technology

The Music Technology option is available only to internal transfer students beginning fall '14.

**Required Courses for Both Concentration Options (19 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-152</td>
<td>Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians</td>
<td>1</td>
</tr>
</tbody>
</table>

**Music Composition Required Courses (66 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-161</td>
<td>Eurhythmics I</td>
<td>3</td>
</tr>
<tr>
<td>57-181</td>
<td>Solfege I</td>
<td>3</td>
</tr>
<tr>
<td>57-69x</td>
<td>BXX Studio (4 semesters)</td>
<td>36</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Major Ensemble (4 semesters)</td>
<td>24</td>
</tr>
</tbody>
</table>

Choose 23 additional Music units in consultation with the Music advisor.

**Music Technology Required Courses (30 units)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-101</td>
<td>Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-181</td>
<td>Solfege I</td>
<td>3</td>
</tr>
<tr>
<td>57-337</td>
<td>Sound Recording</td>
<td>6</td>
</tr>
<tr>
<td>57-347</td>
<td>Electronic and Computer Music</td>
<td>6</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Independent Study in Music Technology or Sound Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose 36 units from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-153</td>
<td>Harmony II</td>
<td>9</td>
</tr>
<tr>
<td>57-182</td>
<td>Solfege II</td>
<td>3</td>
</tr>
<tr>
<td>57-283</td>
<td>Music History I</td>
<td>9</td>
</tr>
<tr>
<td>57-284</td>
<td>Music History II</td>
<td>9</td>
</tr>
<tr>
<td>57-285</td>
<td>Music History III</td>
<td>9</td>
</tr>
<tr>
<td>57-190</td>
<td>Repertoire and Listening for Musicians I (co-requisite: 57-283)</td>
<td>3</td>
</tr>
<tr>
<td>57-289</td>
<td>Repertoire and Listening for Musicians II (co-requisite: 57-284)</td>
<td>3</td>
</tr>
<tr>
<td>57-290</td>
<td>Repertoire and Listening for Musicians III (co-requisite: 57-285)</td>
<td>3</td>
</tr>
<tr>
<td>57-338</td>
<td>Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose 23 additional Music units in consultation with the Music advisor.

**IV. Free Electives**

(approximately 3-4 courses, 29–39 units minimum)

Take any Carnegie Mellon course. A maximum of 9 units of physical education and/or military science may be counted toward this requirement. Physical education and military science courses will not be calculated in a student’s QPA.
Carnegie Institute of Technology

Carnegie Institute of Technology

Undergraduate Designated Minors

CIT Minors for Non-Engineering Students

Department of Biomedical Engineering

Department of Chemical Engineering

Department of Civil and Environmental Engineering

Department of Electrical and Computer Engineering

Department of Engineering and Public Policy

Department of Mechanical Engineering

Department of Materials Science and Engineering
Carnegie Institute of Technology

Vijayakumar Bhagavatula, Interim Dean
Annette M. Jacobson, Associate Dean for Undergraduate Studies
Kurt Larsen, Assistant Dean for Undergraduate Studies
Office: Scaife Hall 110
http://www.cit.cmu.edu/

Carnegie Institute of Technology, the engineering college of the university, has three main activities - undergraduate education, graduate education, and research. Its continuing goal has been to maintain excellence in these activities. The degree to which this goal has been achieved is attested to by the demand for its graduates, the success of its alumni, the quality of its students and faculty, the adoption elsewhere of its innovations, and the national and international recognition it receives in educational and research activities.

The college offers the degree of bachelor of science in chemical engineering, civil engineering, electrical and computer engineering, mechanical engineering, and materials science and engineering. All of these programs are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

An engineering student may also choose to pursue a minor in one of the CIT designated minor programs, or a double major in engineering and public policy or biomedical engineering, or to design a minor, additional major or dual-degree programs with other non-engineering departments.

Educational Objectives

The overarching objective of our engineering curriculum is to provide our students an education that enables them to be productive and fulfilled professionals throughout their careers. Our more specific, measurable objectives for graduates of our engineering curriculum are the following:

- Graduates recognize that they acquired a high quality, rigorous technical education from the College of Engineering at Carnegie Mellon.
- Graduates, in addition to their technical knowledge, recognize that they have acquired a broader body of knowledge that allows them to understand the larger context of the problems that they must address during their career.
- Graduates use their technical foundation and their broader base of knowledge to be successful in a diverse collection of individual careers inside and outside of the engineering profession.

From its earliest days, Carnegie Institute of Technology (CIT) has considered undergraduate education to be the key element in the development of future leaders. In this regard, CIT has adopted a plan for education that is designed to equip students with the capacity to learn and to continue the process of self-education throughout their lives. The present curriculum incorporates this philosophy by providing the opportunity for both breadth in a number of engineering, science, humanities and fine arts areas as well as depth in a major area of concentration. To achieve these goals, our flexible curriculum has been designed to allow students to customize their program to suit their needs and to help each student acquire:

- A thorough and integrated understanding of fundamental knowledge in fields of a students' major interest and the ability to use this knowledge;
- Competence in the orderly way of thinking, which professionals and scientists have always used in reaching sound, creative conclusions, with the goal that after graduation the student can, by such thinking, reach decisions both as a professional and as a citizen;
- An ability to learn independently with scholarly orderliness, so that after graduation the student will be able to grow in wisdom and keep abreast of the changing knowledge and problems of the profession and the society in which he or she participates;
- The philosophical outlook, breadth of knowledge, and sense of values which will increase the student's understanding and enjoyment of life and enable each student to recognize and deal effectively with the human, economic, ethical and social aspects of professional problems; and
- The ability to communicate ideas to others in a comprehensive and understandable manner.

The curriculum encourages students to confront professional problems, accomplished through team and problem-oriented courses, as well as courses which emphasize design or individual projects. These classes stress creativity and independent thought and require the student to define the problem, propose a solution or a design in the presence of technical and socioeconomic constraints, to make judgments among alternative solutions, and to explore innovative alternatives to more conventional solutions.

First Year for Engineering Students

The Carnegie Mellon engineering education is based on engineering and science fundamentals that give students the skills to face new and challenging situations. The first year in engineering provides a broad foundation upon which students build a curriculum in their eventual major. Since students in CIT do not select a major until the end of the first year, all first year students share a common experience consisting of introductory courses in the engineering majors (one each semester), calculus, physics, other science courses which complement specific introductory engineering courses, and courses in the College of Humanities and Social Sciences (General Education). This curriculum helps make an informed decision about a final major. Below is an example of a standard schedule for a first-year engineering student.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory Engineering Elective</td>
<td>12</td>
</tr>
<tr>
<td>Restricted Technical Elective</td>
<td>9-12</td>
</tr>
<tr>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>General Education 5</td>
<td>9</td>
</tr>
<tr>
<td>Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>Introductory Engineering Elective</td>
<td>12</td>
</tr>
<tr>
<td>Restricted Technical Elective</td>
<td>10</td>
</tr>
<tr>
<td>Integration, Differential Equations</td>
<td>10</td>
</tr>
<tr>
<td>General Education Course 5</td>
<td>9</td>
</tr>
</tbody>
</table>

Notes:

1. Each semester every CIT department offers its Introductory Engineering Elective. Every first year CIT student must select one such course each semester.
2. Each Introductory Engineering Elective requires a specific Restricted Technical Elective (as a pre- or co-requisite) as given below:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical Engineering</td>
<td>03-121</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>09-105</td>
</tr>
<tr>
<td>Civil &amp; Environmental Engineering</td>
<td>33-106</td>
</tr>
<tr>
<td>Electrical &amp; Computer Engineering</td>
<td>15-110 or 15-121</td>
</tr>
<tr>
<td>Engineering &amp; Public Policy</td>
<td>33-106</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>33-106</td>
</tr>
<tr>
<td>Materials Science &amp; Engineering</td>
<td>33-106</td>
</tr>
</tbody>
</table>

3. Restricted Technical Electives include the following courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>Introduction to Data Structures</td>
<td>10</td>
</tr>
<tr>
<td>Physics I for Engineering Students</td>
<td>22</td>
</tr>
</tbody>
</table>

4. All students must complete 33-106 Physics I for Engineering Students by the end of the first year. Therefore, if a student chooses to take Introduction to Chemical Engineering (with 09-105 as a co-requisite) during one semester and Introduction to Electrical and Computer Engineering (with 15-110 as a co-requisite), the student must take 33-106 in place of the General Education requirement in the Spring semester of the first year and take the General Education course in a subsequent semester. Alternatively, a student entering the university with AP credit in a required first year course may substitute 33-106 in its place.

2. Interpretation and Argument, 76-101, should be completed in the first year. Some students for whom English is not a native language, may have to take 76-100 first.
**Program in General Education for CIT Students for the Class of 2015 and earlier**

**Breadth Requirement** 27 Units

<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanistic Studies (Cultural Analysis)*</td>
<td>9</td>
</tr>
<tr>
<td>Cognitions and Institutions*</td>
<td>9</td>
</tr>
<tr>
<td>Writing/Expression **</td>
<td>9</td>
</tr>
</tbody>
</table>

*A list of acceptable courses for Humanistic Studies and Cognitions and Institutions is available at www.cit.cmu.edu in the General Education section.

**The Writing/Expression requirement consists of the following course:**

76-101 Interpretation and Argument (1 units)

**Deph Sequence in Humanities, Social Science, or Fine Arts units**

A sequence of humanities, social science, or fine arts courses which provides insight in a single area. Usually, 2 units from a single department meet this requirement. However, related courses from different departments may also satisfy this requirement. A depth sequence in language must include at least three nine-unit courses in the same language. Statistics Department courses may NOT be used to satisfy this requirement. Courses from Business Administration (70-xxx) and Heinz College that are on the above "Acceptable Non-H&SS/CFA courses for Non-Technical Electives" list can be used as part of a Depth Sequence. Although this requirement is typically satisfied by completing 3 courses of at least 9 units each, some acceptable courses are greater or less than 9 units (e.g. 6-unit Art courses). While mini courses of fewer than 9 units may be combined to equal 9 unit courses, the excess units from courses greater 9 units may NOT be used to satisfy this requirement. For example, a 12 unit, 6 unit, 9 unit combination is not acceptable. A 6 unit, 3 unit, 9 unit, 9 unit combination is acceptable.

Non-Technical Electives 18 units

Two unrestricted humanities, social science or fine arts courses. Non-technical courses from Business Administration, or the Heinz College may also satisfy this requirement. Accounting, finance, management, marketing, production, and statistics courses are regarded as technical courses and may NOT be used to satisfy this requirement. Although this requirement is typically satisfied by completing 2 courses of at least 9 units each, some acceptable courses are greater or less than 9 units (e.g. 6-unit Art courses). While mini courses of fewer than 9 units may be combined to equal 9 unit courses, the excess units from courses greater 9 units may NOT be used to satisfy this requirement. For example, a 12 unit, 6 unit, 9 unit combination is not acceptable. A 6 unit, 3 unit, 9 unit combination is acceptable.

Free Elective Courses

A free elective is any graded Carnegie Mellon course. However, a maximum of nine units in the form of pass/fail or non-factorable courses (including physical education, StuCo and military science) may be taken as free electives in most CIT degree programs.

**Program in General Education for CIT students for the Class of 2016 and later**

The environment in which today's engineering graduates will find themselves working is evolving rapidly. Technical innovation is becoming ever more critical to retaining a competitive edge. This is true for individuals, for firms and for nations. Start-ups, as well as established companies, have significant international opportunities but also face more competition in a global economy. Seizing these opportunities and dealing with the associated challenges requires an understanding of the global context in which engineers work, as well as understanding multi-disciplinary approaches to technological innovation across cultures.

The College of Engineering has developed General Education Requirements designed to ensure that our students are ready to work effectively in the global economy, and become the innovators and leaders of tomorrow.

*Complete the following requirements to graduate (72 units):*

**FRESHMAN YEAR**

1. 76-101 Interpretation and Argument (some students may need to take 76-100 first)
2. One course from the following list:
   - 73-100 Principles of Economics 9
   - 73-230 Intermediate Microeconomics 9
   - 85-102 Introduction to Psychology 9

**AFTER FRESHMAN YEAR**

Students must complete each of the categories (descriptions of categories follow below):

- **Innovation & Internationalization (I&I)**
  - 9 units from the I&I list of courses (which could be two 4.5 unit courses);
- **Peoples, Places, and Cultures (PPC)**
  - 9 units from the PPC list; or a 9-12 unit course in a modern language at the 200+ level
- **Social Analysis and Decision Making (SDM)**
  - 9 units from the SDM list of courses (which could be two 4.5 unit courses)
- **Writing and Expression (W&E)**
  - 9 units from the W&E list of courses (in addition to 76-101)
- **General Education Electives**
  - At least 18 units (any combination) from the four categories: I&I, PPC, SDM or W&E, or non-technical academic courses from the Dietrich College or the College of Fine Arts excluding those listed on this site: http://www.cit.cmu.edu/current_students/services/general_education.html#unaccept_depth

* Students can receive exemption through an approved study abroad program (these students would then have three General Education Electives to complete instead of two)

**LIFELONG LEARNING (LLL)**

- 6 LLL points by participating in a variety of approved activities in the following timeframe:
  - 2 points sophomore fall semester
  - 2 points sophomore spring semester
  - 2 points junior fall semester

* A list of acceptable courses to complete these requirements is available at www.cit.cmu.edu/gen-ed

**GENERAL EDUCATION CATEGORIES**

**People, Places and Cultures (PPC)**

PPC courses are designed to help you gain better understanding of the diversity of the world in which we live, and the way in which social, political, economic and technical factors interact to shape that world.

**Social Analysis and Decision Making (SDM)**

SDM courses are focused on helping you to gain an understanding of different ways in which individuals and societies approach and make decisions.

**Innovation and Internationalization (I&I)**

I&I courses are intended to expose to you the opportunities and potential that engineering provides with regard to developing cutting-edge technologies and leveraging the fundamental skills you gain in your education to make these pioneering ideas come to fruition in a global context.

**Lifelong Learning (LLL)**

Being curious and constantly looking for inspiration are critical parts of lifelong learning. To be successful as an engineer and as a citizen, your education must not stop when you graduate from Carnegie Mellon. The LLL requirement aims to encourage a habit of lifelong learning about innovation and the growing internationalization in engineering and, indeed of many other aspects of the modern world. The goal of this requirement is to help inspire the habits of being open to new ideas as successful, innovative engineers.

To do that, during both semesters of your sophomore year, and the first semester of your junior year, we require you to choose a few related activities that are not part of your formal course work. Examples could include:

- Attending approved seminars and then submitting a one page write up of your thoughts on what you heard;
Additional Majors and Dual Degrees in CIT

A major is defined as a program that must be completed for the granting of a degree. Additional majors comprise a single degree with majors in two separate areas; for example, the degree of Bachelor of Science in Chemical Engineering and an additional major in English. Although the additional major requires the completion of two designated programs, they may have overlapping requirements that can be met simultaneously. The general principle used to measure eligibility for a Carnegie Institute of Technology additional major is that the major (core) requirements of both departments must be completed. Finally, although the student is formally enrolled as an undergraduate in one of the departments (the parent department, which is responsible for scheduling and other administrative actions for the student), the student should apply for the additional major through the second department and coordinate requirements with both departments.

The additional major is to be distinguished from a dual degree program, which results in two separate bachelor’s degrees; for example, Bachelor of Science in Chemical Engineering and a Bachelor of Arts in English. The dual degree, though, requires a minimum of 90 units of work in addition to the units required for the first degree. The second degree may be earned in Bachelor of Science or Bachelor of Arts degree programs.

Requirements for students wishing to complete Additional Majors in CIT

Note: This applies to all students.

The student must satisfactorily pass all requirements of the regular and complete program (with the permissible exceptions) leading to a degree in CIT. The minimum number of units required for the additional major is the number required by the parent department or major.

The student takes and satisfactorily completes the courses specified by a second department, usually using elective space available in the first program.

The second department, on the basis of the specified number of courses plus the courses comprising the parent department’s regular degree requirements, then certifies that the student has completed the requirements for a major in the second department.

Equivalent technical electives may be substituted at the discretion of the departments/colleges.

Non-technical courses in the curricula can be used to meet the requirements of the second major. But if the second major is not an H&SS department, the program must include a minimum of 72 units of General Education courses to meet CIT requirements for graduation.

Designated Minors Offered by CIT

(for engineering students)

In addition to their regular majors for B. S. degrees, undergraduate students in the Carnegie Institute of Technology can elect to complete an interdisciplinary Designated Minor. These minors have been added to the Carnegie Institute of Technology curriculum to promote flexibility and diversity among the college’s engineering students. Independent of major, a student is free, but not required, to pursue a selected designated minor from the following list:

- Audio Engineering
- Automation and Control
- Biomedical Engineering*
- Colloids, Polymers and Surfaces
- Electronic Materials
- Environmental Engineering and Sustainability
- Global Engineering
- Manufacturing Engineering
- Material Science and Engineering
- Mechanical Behavior of Materials
- Robotics*

* Also available for non-CIT students

Complete descriptions of the designated minors can be found at http://coursecatalog.web.cmu.edu/carnegieinstituteoftechnology/undergraduatedesignedminors/.

To add a CIT Designated Minor, please contact the director listed for each minor.

Minors for Non-Engineering Students

Students in a non-engineering discipline can also declare certain CIT minors:

- Biomedical Engineering
- Engineering Studies
- Technology and Policy
- Robotics

A full listing of curriculum for these minors when taken by non-engineering students can be found at http://coursecatalog.web.cmu.edu/carnegieinstituteoftechnology/minorsformonengineeringstudents/.

Academic Standards

Grading Practices

Undergraduate grading regulations can be found at http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations/.

CIT Dean’s Honor List

Each semester, Carnegie Institute of Technology recognizes students who have earned outstanding academic records by naming them on the dean’s honor list. The criterion for such recognition is a semester quality point average of at least 3.75 while completing at least 36 factorable units and earning no incomplete grades.

Transfer into CIT Departments

Undergraduate students admitted to colleges other than CIT who wish to transfer into a CIT department during their first year should consult with an advisor in the Office of Undergraduate Studies in the CIT Dean’s Office. Students admitted to CIT but excluded from certain departments must also consult with the CIT Dean’s Office if they wish to transfer into a restricted CIT department.

First-year students can apply for transfer after mid-semester grades for the spring semester have been posted. At that time, a decision will be based on availability of space and the student’s academic performance.

CIT undergraduate students beyond the first year wishing to transfer into another CIT department may apply if they are in good academic standing and if there is room in the department of their choice. If the demand for any department exceeds the space available, then the department will admit students based on a comparative evaluation of all applicants at the end of each semester, up to the limit of available space.

Undergraduate students not in CIT who wish to transfer into a CIT department during their first year should consult with a CIT advisor in the Office of Undergraduate Studies in the CIT Dean’s Office. Undergraduate students admitted to colleges other than CIT who wish to transfer into CIT departments: A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student’s record is sent to the appropriate department for evaluation and a decision on acceptance. The CIT department head has the right to refuse to accept the student if there are space restrictions and/or if the student’s chance for success in the CIT department is determined to be questionable based on past academic performance.

Academic Actions

In the first year, a student’s quality point average below 1.75 in either semester invokes an academic action. For all subsequent semesters, a student’s semester GPA or the cumulative GPA (excluding the first year) below 2.0 invokes an academic action.

Probation

The action of probation occurs in the following cases:

- One semester GPA of the first year falls below 1.75.
- The semester GPA of a student in good standing beyond the first year falls below 2.00.

* Also available for non-CIT students

Note: This applies to all students.
The term of probation is one semester as a full-time student. First year students are no longer on probation at the end of the semester if their semester QPA is 1.75 or above. Students in the third or subsequent semester of study are no longer on probation at the end of one semester if the semester QPA AND cumulative QPA (excluding the first year) are 2.00 or above.

Probation Continued
A student who is currently on one semester of probation but whose record indicates that the standards are likely to be met by the end of the next semester may be continued on probation at the discretion of the associate dean.

Suspension
A student who does not meet minimum standards at the end of one semester of probation will be suspended.

A first year student will be suspended if the QPA from each semester is below 1.75.

A student in the third or subsequent semester of study will be suspended if the semester QPA or the cumulative QPA (excluding the first year) is below 2.00 for two consecutive semesters.

The normal period of suspension is one academic year (two semesters). At the end of that period a student may petition to return to school (on probation) by completing the following steps:

1. Writing a formal petition requesting to return and receiving permission in writing from the assistant dean for undergraduate studies.
2. Completing a Return from Leave of Absence form from Enrollment Services; and
3. Providing transcripts and clearance forms if the student has been in a degree program at another college or university even though academic credit earned will not transfer back to Carnegie Mellon unless prior approval from the Assistant Dean is given.

Students who are suspended, take a leave of absence or withdraw are required to vacate the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes debarment from part-time or summer courses at the university for the duration of the period of the action.

Drop
This is a permanent severance. A student is dropped when it seems clear that the student will never be able to meet minimum standards. A student who has been suspended and fails to meet minimum standards after returning to school is dropped.

If students are dropped, they are required to vacate campus (including dormitories and fraternity houses) within a maximum of two days after the action. This action includes debarment from part-time or summer courses.

The relation indicated above between probation, suspension, and drop is normal, not binding. In unusual circumstances, College Council may suspend or drop a student without prior probation.

Graduation Requirements
A requirement for graduation is the completion of the program-specified degree with a cumulative quality point average of at least 2.00 for all courses taken after the first year. In addition, a student is expected to achieve a cumulative quality point average of 2.00 in core departmental courses.

Students must be recommended for a degree by the faculty of CIT.

A candidate must meet the residence requirement of having completed at least 180 units at Carnegie Mellon University.

Students must meet all financial obligations to the university before being awarded a degree.

Modification of Graduation Requirements: A student may seek permission to modify graduation requirements by petition to the CIT College Council.

Other Regulations Affecting Student Status

Schedule Changes
Add/drop procedure information can be found at http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations/.

Grading procedures for dropped courses can be found at http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations/.

Course Add Deadline
The last date to ADD courses is stipulated for each semester on the university calendar—about two weeks after the beginning of a term. This applies to all courses with the following exception: the final date to add half-semester mini-courses is the last class day of the first week of the course.

Course Drop/Withdraw Deadline
CIT undergraduate students may DROP a course on-line on or before the deadline published in the official university calendar. This deadline is two weeks after mid-semester grades are due in The HUB. The deadline to drop a half-semester mini course is the last day of the fourth week of the mini course. When a course is dropped by the deadlines, the course is removed entirely and disappears from a student’s academic record. After the official university deadline to drop, undergraduate students may WITHDRAW from a course on-line on or before the last day of classes, excluding final examinations. The deadline to withdraw from a half-semester mini course is the last class day of the mini course. When a student withdraws from a course between the official university deadline to drop a course and the last day of classes, a “W” (Withdrawal) is assigned as a grade, which appears on the student’s academic record. This “W” grade does not affect a student’s QPA.

CIT undergraduates who are registered as full time students as of the tenth class day are expected to remain full time for the duration of a semester. Full time is defined by being registered for a minimum of 36 factorable units. Students may not drop or withdraw from courses that will reduce their factorable units below 36 unless there are extenuating circumstances for which they obtain approval from the CIT College Council. Undergraduates who are registered as part time (those carrying fewer than 36 factorable units) as of the 10th class day are also subject to the above deadlines to drop or withdraw from a course.

Exceptions to the regulations above will be granted only upon approval of a petition to the College Council.
Undergraduate Designated Minors in Carnegie Institute of Technology

Undergraduate students in the Carnegie Institute of Technology can elect to complete an interdisciplinary Designated Minor in addition to their regular majors for B.S. degrees. Designated minors have been added to the curriculum of the Carnegie Institute of Technology to promote flexibility and diversity among the college’s engineering students. Independent of a student’s major, he or she is able to pursue a selected designated minor from the following list:

- Audio Engineering
- Automation and Controls
- Biomedical Engineering
- Colloids, Polymers and Surfaces Technology
- Electronic Materials
- Environmental Engineering
- Global Engineering
- Manufacturing Engineering
- Materials Science and Engineering
- Mechanical Behavior of Materials
- Robotics (see “CIT Minors for Non-Engineering Students (p. 98)”)

An engineering student may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineering major but uses electives to take courses needed to fulfill the requirements of the designated minor. Upon completion of the requirements of a CIT designated minor and the engineering degree, the minor is a formally recognized on the student’s transcript.

Each of the CIT designated minors is administered by a Program Committee consisting of faculty from all major engineering departments who serve as faculty advisors. Each Program Committee certifies the completion of requirements of the designated minor. But the student’s major department is responsible for approving the degree with a designated minor after reviewing a student’s entire academic record. Any substitution or departure from the published curriculum should be avoided. For example, non-technical courses may not be substituted for required technical courses or electives. Equivalent technical electives offered by a designated minor as substitutions for required courses in a major must be approved by the Head of the student’s major department.

Although a student generally can complete a designated minor without increasing the number of required units for graduation, early planning in selecting a designated minor is important. A student also may find that some minors are more compatible than others with his/her major because of different relations between various major and minor requirements. The requirements for these CIT designated minors are listed below.

Audio Engineering Designated Minor

Tom Sullivan, Director

This sequence is for candidates who are engineering majors with interest in and/or have background in music, recording, sound-editing and/or other music technology areas; or majors from any discipline in the university who have the above interests and who can meet the prerequisite requirements for the engineering courses in the minor.

Note: Students who do not have the requisite engineering/science/math background should investigate the Minor in Music Technology offered by the School of Music.

Faculty Advisor
Tom Sullivan

Course Requirements

The student must have taken the appropriate prerequisite courses for the listed courses.

Prerequisite Courses, 0-3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

Music Courses, 40-43 units

Basic Harmony I is required of students who do not qualify for entrance into Harmony I, based on their scores on the theory placement test.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-101</td>
<td>Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-149</td>
<td>Basic Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>57-152</td>
<td>Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians</td>
<td>1</td>
</tr>
<tr>
<td>57-337</td>
<td>Sound Recording</td>
<td>6</td>
</tr>
</tbody>
</table>

* co-requisite 57-188.

(choose two of the courses below)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-322</td>
<td>Introduction to Computer Music</td>
<td>9</td>
</tr>
<tr>
<td>57-338</td>
<td>Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-347</td>
<td>Electronic and Computer Music</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Other courses may be taken with the approval of the Audio Engineering Minor Advisor.

Technical Courses, 33 units

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-114</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>18-493</td>
<td>Electroacoustics</td>
<td>12</td>
</tr>
</tbody>
</table>

** prerequisites 18-220 and 18-290.

(choose one of the courses below)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-210</td>
<td>Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>or 15-214</td>
<td>Principles of Software Construction: Objects, Design, and Concurrency</td>
<td>12</td>
</tr>
<tr>
<td>18-320</td>
<td>Microelectronic Circuits</td>
<td>12</td>
</tr>
<tr>
<td>18-348</td>
<td>Embedded Systems Engineering **</td>
<td>12</td>
</tr>
<tr>
<td>18-349</td>
<td>Embedded Real-Time Systems **</td>
<td>12</td>
</tr>
<tr>
<td>18-391</td>
<td>Noisy Signal Representation and Processing *</td>
<td>12</td>
</tr>
</tbody>
</table>

* prerequisite 18-290.

** prerequisite 18-240 and 18-213.

+ prerequisite 18-220.

Units required for minor: 73.79

Automation and Controls Designated Minor

Erik Ydstie, Director
Office: DH 4210 A

The objective of the Designated Minor in Automation and Control Engineering is to expose CIT students to the breadth of knowledge required by the modern practice of control and automation. With this objective in mind, the requirements include not only two courses in control system analysis and design, but also courses on real-time computation, software engineering, hardware implementation, and applications. The minor is expected to attract primarily students from Chemical Engineering, Electrical and Computer Engineering, and Mechanical Engineering. The main interdisciplinary component of the minor is between engineering and computer science, although many opportunities exist for creating a program across several CIT departments.

Faculty Advisor
All CIT departments — Erik Ydstie

Course Requirements

The minor requires a minimum of six courses as described below:

Note: The course lists below are not necessarily current or complete. Appropriate courses not listed below may be counted toward the requirements for the minor upon approval by one of the departmental faculty advisors. Students interested in the Automation and Control...
Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

One basic control course: 18-370 Fundamentals of Control 12
24-451 Feedback Control Systems 12

One course on control system analysis and design: 06-708 Advanced Process Dynamics and Control 12
18-771 Linear Systems 12

One course on computing and software: 15-211 Fundamental Data Structures and Algorithms 12
12-741 Data Management 6
18-549 Embedded Systems Design 12
18-649 Distributed Embedded Systems 12

One course on hardware implementation: 06-423 Unit Operations Laboratory 9
18-474 Embedded Control Systems 12
18-378 Mechanic Design 12

One course on applications: 06-606 Computational Methods for Large Scale Process Design & Analysis 9
16-311 Introduction to Robotics 12
16-761 Mobile Robots 12
24-356 Engineering Vibrations 11
24-451 Dynamics 10
xx-xxx Independent project 12

One elective course: 06-609 Any course in the list above excluding the basic control course category 6-12
15-381 Artificial Intelligence: Representation and Problem Solving 9
15-385 Computer Vision 9
15-413 Software Engineering Practicum 12
15-440 Distributed Systems-Time Software 12
18-348 Embedded Systems Engineering 12
18-349 Embedded Real-Time Systems 12
18-491 Fundamentals of Signal Processing 12
18-771 Linear Systems 12
24-341 Manufacturing Sciences 9

Biomedical Engineering Minor
Conrad M. Zapanta, Ph.D.
www.bme.cmu.edu

BME offers a minor program for those students who desire coordinated training in BME but may not have the time to pursue the BME additional major. The Biomedical Engineering Minor is designed to train students in applying engineering techniques to problems in medicine and biology. Emphasis is placed on describing biological organisms as engineering systems and on applying engineering technology to clinical and laboratory situations.

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Biomedical engineering or basic biomedical sciences at either the master’s or Ph.D. level. In addition, some of the courses in BME minor will assist students in preparing for medical school. Students who pursue jobs in biomedical engineering are involved in developing and improving medical devices, automating medical procedures using information technology, characterizing the operation of physiological systems, designing artificial organs, and altering microbes and mammalian cells for the production of useful drugs and chemicals.

The Biomedical Engineering Minor accepts undergraduate students from both within and outside CIT. Students in the minor program can choose from a wide range of electives to build skills in a number of areas of biomedical engineering. Students who wish to complete the Biomedical Engineering Designated Minor should contact the Associate Head of the Department of Biomedical Engineering (http://www.bme.cmu.edu/bme/contact.html).

Requirements for all BME Minor students: six courses, minimum of 57 units
03-211 Modern Biology 9
42-101 Introduction to Biomedical Engineering 12
(co-req. or pre-req. 03-121)
42-202 Data Management 9
(pre-req. 03-121 or permission of instructor)
42-xxx BME Elective: Any course offered by the Department of Biomedical Engineering numbered 42-300 or higher (= 9 units)
xx-xxx Elective I (= 9 units)
xx-xxx Elective II (= 9 units)

Electives I and II may be selected from the following (see notes # and +):

1. Any Track Gateway, Track Elective or Track Capstone course selected from any of the four Biomedical Engineering tracks. A list of track electives is provided under the BME Additional Major listing in the catalog and is periodically updated on this website.
2. Any course with a 42-5xx or 42-6xx number.
3. 42-203 Biomedical Engineering Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program)**
4. One semester of 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 Honors Research Project, as long as the research project is supervised by a regular or courtesy Biomedical Engineering faculty member and the project is conducted for 9 or more units of credit.
5. Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Notes:
# This course cannot be a required course in the student’s major.
+ This course must be a Biomedical Engineering Track Gateway, Track Elective or Track Capstone course that is offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx).

The only exception is that 03-232, the biotechnology version of Biochemistry I taught each spring by the Department of Biological Sciences, is also acceptable provided students meet the prerequisite and corequisites for that course.

** Priority for enrollment in 42-203 or 03-206 will be given to students who have declared the Additional Major in Biomedical Engineering. If sufficient room in the course remains after all majors have been accommodated in a given semester, students who have declared the Biomedical Engineering Designated Minor will be given the next priority for enrollment. If space still allows, other students will be enrolled.

Colloids, Polymers and Surfaces Designated Minor
Annette Jacobson, Director
Office: Doherty Hall 3102B
Website: http://www.cit.cmu.edu/current_students/services/majors_minors/engineering_minors/cps.html

The sequence of courses in the Colloids, Polymers and Surfaces (CPS) Designated Minor provides an opportunity to explore the science and engineering of fine particles and macromolecules as they relate to complex fluids and interfacially engineered materials. These topics are very relevant to technology and product development in industries that manufacture pharmaceuticals, coatings and paints, pulp and paper, biomaterials, surfactants and cleaning products, cosmetics and personal care products, food, textiles and fibers, nanoparticles, polymer/plastics, composite materials.

Course Requirements
This minor requires a total of five classes. The following four courses are mandatory:
06-409/09-509 Physical Chemistry of Macromolecules 9
06-607 Physical Chemistry of Colloids and Surfaces 9
06-426 Experimental Colloid Surface Science 9
06-446 Experimental Polymer Science 9

In addition, the student must take one course from the following list:
06-221 Thermodynamics 9
24-221 Thermodynamics I 10
27-215 Thermodynamics of Materials 12
33-341 Thermal Physics I 10
09-349 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry 9

Electronic Materials Designated Minor
David W. Greve, Director
Office: Hamerschlag Hall B204
Lisa A. Porter, Co-Director
Office: Roberts Engineering Hall 145
Website: http://www.cit.cmu.edu/current_students/services/majors_minors/engineering_minors/electronic_materials.html

Many of the technological changes in recent decades—notably the rise of digital data processing—have been made possible by continuing advances in
the performance of electronic devices. These advances include continuous improvement in microprocessor performance, optical communication bandwidth, and magnetic disk storage capacity. Other new areas of innovation include the development of micromechanical systems and the development of flat panel display technology. These advances depend on interactions between engineers from many different disciplines. In particular, there is a strong interaction between device design and materials engineering and processing.

The Electronic Materials Minor is intended to provide students with a firm basis for the application of electronic materials in advanced systems. This minor is well suited for students who intend to pursue careers in the electronics industry (included, but not limited to, semiconductor integrated circuit design and manufacturing, and magnetic storage engineering). The minor also provides an excellent preparation for students interested in pursuing graduate work in MSE, ECE, or Applied Physics.

This minor is primarily intended to offer ECE and MSE students an understanding of the important features that must be built into a material during processing so that it will function as required in an electronic or magnetic device. Other students interested in pursuing this minor should consult their advisors to determine whether it will be practical in their own curriculum. Such students are expected to take both 18-100 and 27-201 as introductory courses.

Students in the Electronic Materials program are urged to consider registering for an undergraduate project in addition to the requirements below, especially if they intend to apply to graduate school. The co-directors will make every effort to arrange a suitable project for interested students.

Course Requirements
The minor requires an introductory course together with a minimum of 48 additional units as specified below.

Required Introductory Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-100</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>12</td>
</tr>
<tr>
<td>27-201</td>
<td>Structure of Materials (ECE students)</td>
<td>9</td>
</tr>
</tbody>
</table>

Elective Courses:

48 additional units, with 24 units from Group A and 24 units from Group B. Some courses are a required part of one of the curricula and consequently cannot be counted again for the minor program.

We have determined that “courses which are a required part of a curriculum” are those which are specifically named in the curriculum requirements. Consequently technical electives and breadth and depth electives may be double-counted.

Group A

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-202</td>
<td>Defects in Materials (ECE students only)</td>
<td>9</td>
</tr>
<tr>
<td>06-619</td>
<td>Semiconductor Processing Technology</td>
<td>9</td>
</tr>
<tr>
<td>27-542</td>
<td>Processing and Properties of Thin Films</td>
<td>9</td>
</tr>
<tr>
<td>27-217</td>
<td>Phase Relations and Diagrams (ECE students only)</td>
<td>12</td>
</tr>
<tr>
<td>27-533</td>
<td>Principles of Growth and Processing of Semiconductors</td>
<td>6</td>
</tr>
<tr>
<td>27-432</td>
<td>Electronic and Thermal Properties of Metals, Semiconductors and Related Devices</td>
<td>9</td>
</tr>
<tr>
<td>27-433</td>
<td>Dielectric, Magnetic, Superconducting Properties of Materials &amp; Related Devices (only if not required in your curriculum)</td>
<td>9</td>
</tr>
<tr>
<td>27-551</td>
<td>Properties of Ceramics and Glasses</td>
<td>9</td>
</tr>
<tr>
<td>27-216</td>
<td>Transport in Materials (ECE students only)</td>
<td>9</td>
</tr>
<tr>
<td>33-225</td>
<td>Quantum Physics and Structure of Matter (ECE students only)</td>
<td>9</td>
</tr>
</tbody>
</table>

Group B

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-310</td>
<td>Fundamentals of Semiconductor Devices</td>
<td>12</td>
</tr>
<tr>
<td>18-715</td>
<td>Physics of Applied Magnetism</td>
<td>12</td>
</tr>
<tr>
<td>18-716</td>
<td>Advanced Applied Magnetism</td>
<td>12</td>
</tr>
<tr>
<td>18-Bxx</td>
<td>An appropriate B00-level course (for example, 18-813, 18-815, 18-819)</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: Other appropriate courses may be substituted with the approval of the coordinators in the event that limited course offerings make it impossible to satisfy the requirements as described above.

Environmental Engineering and Sustainability Designated Minor

Jeanne VanBriesen, Director
Office: Porter Hall 119

Concern for the environment now influences a wide range of public, private and engineering decisions. Environmental Engineering is widely recognized as a discipline at the graduate and professional level, and undergraduate training in environmental issues and processes can provide the preparation necessary to pursue this career path, or serve as a useful complement to a career in any of the traditional areas of engineering. Sustainability issues are not considered critical across engineering disciplines. Effective preparation requires broad knowledge and skills in the areas of environmental engineering, sustainability, and environmental policy.

Faculty Advisors

The Environmental Engineering program is a focus for faculty members from diverse engineering backgrounds. The faculty are actively engaged in teaching and conducting research in this field. Current faculty advisors are:

- Biomedical Engineering — Robert Tilton
- Chemical Engineering — Neil M. Donahue
- Civil and Environmental Engineering — Peter Adams and Scott Matthews
- Electrical and Computer Engineering — Marija Ilic
- Engineering and Public Policy — Edward Rubin
- Mechanical Engineering — TBD
- Materials Science and Engineering — Paul Salvador and Robert Heard

Course Requirements

The requirements include two core courses, three technical electives, and two policy electives.

A1. Core Courses in Sustainability (12 units)

Select one course from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/19-712</td>
<td>Introduction to Sustainable Engineering</td>
<td>12</td>
</tr>
<tr>
<td>12/19-714</td>
<td>Environmental Life Cycle Assessment</td>
<td>12</td>
</tr>
</tbody>
</table>

A2. Core Courses in Environmental Engineering (9 units)

Select one course from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-351</td>
<td>Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>24/19-424</td>
<td>Energy and the Environment</td>
<td>9</td>
</tr>
<tr>
<td>12-451</td>
<td>Air Quality Engineering</td>
<td>9</td>
</tr>
<tr>
<td>24-425</td>
<td>Combustion and Air Pollution Control</td>
<td>9</td>
</tr>
<tr>
<td>12-702</td>
<td>Fundamentals of Water Quality Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>

B. Technical Electives in Environmental Engineering and Sustainability (27 units)

Select three from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-510</td>
<td>Introduction to Green Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>12-201</td>
<td>Geology</td>
<td>9</td>
</tr>
<tr>
<td>12-351</td>
<td>Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-451</td>
<td>Air Quality Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-702</td>
<td>Fundamentals of Water Quality Engineering</td>
<td>12</td>
</tr>
<tr>
<td>12-657</td>
<td>Water Resources Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-658</td>
<td>Hydraulic Structures</td>
<td>9</td>
</tr>
<tr>
<td>24-424</td>
<td>Energy and the Environment</td>
<td>9</td>
</tr>
<tr>
<td>24-425</td>
<td>Combustion and Air Pollution Control</td>
<td>9</td>
</tr>
<tr>
<td>12/19-712</td>
<td>Introduction to Sustainable Engineering</td>
<td>12</td>
</tr>
<tr>
<td>12/19-714</td>
<td>Environmental Life Cycle Assessment</td>
<td>12</td>
</tr>
<tr>
<td>12-718</td>
<td>Sustainable Engineering Project</td>
<td>12</td>
</tr>
<tr>
<td>27-322</td>
<td>Processing of Metals **</td>
<td>9</td>
</tr>
<tr>
<td>27-323</td>
<td>Powder Processing of Materials **</td>
<td>9</td>
</tr>
<tr>
<td>27-421</td>
<td>Processing Design **</td>
<td>6</td>
</tr>
<tr>
<td>27-367</td>
<td>Selection and Performance of Materials *</td>
<td>6</td>
</tr>
<tr>
<td>27-594</td>
<td>Electrochemical Degradation of Materials</td>
<td>9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate &amp; Energy</td>
<td>9</td>
</tr>
<tr>
<td>48-415</td>
<td>Advanced Building Systems</td>
<td>9</td>
</tr>
</tbody>
</table>

* 6 units; must be combined with 3 additional units
** Students may take either 27-322 Processing of Metals, or , but not both, as technical electives for list B.

C. Policy Electives (18 units)

Select two from the following list of humanities/social science-oriented courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-448</td>
<td>Science, Technology &amp; Ethics</td>
<td>9</td>
</tr>
<tr>
<td>48-576</td>
<td>Mapping Urbanism</td>
<td>9</td>
</tr>
<tr>
<td>73-357</td>
<td>Regulation: Theory and Policy</td>
<td>9</td>
</tr>
<tr>
<td>73-358</td>
<td>Economics of the Environment and Natural Resources</td>
<td>9</td>
</tr>
<tr>
<td>73-359</td>
<td>Benefit-Cost Analysis</td>
<td>9</td>
</tr>
<tr>
<td>76-319</td>
<td>Environmental Rhetoric</td>
<td>9</td>
</tr>
<tr>
<td>79-326</td>
<td>History of German Cinema History of Modern Germany through its Cinema</td>
<td>9</td>
</tr>
<tr>
<td>79-303</td>
<td>Pittsburgh and the Transformation of Modern Urban America</td>
<td>9</td>
</tr>
</tbody>
</table>
Global Engineering Designated Minor

Treci Bonime, Director
Office: Scaife Hall 130

Many engineers work on international projects or for multinational companies. Carnegie Mellon is an international community, with a significant fraction of international students and many events featuring foreign speakers and cultural experiences. This minor is intended for engineering students interested in broadening their background in international experiences and global awareness and engagement.

Course Requirements

International Management (1 course)

Complete one course in international management or business such as:

- 70-342 Managing Across Cultures 9
- 70-365 International Trade and International Law 9
- 70-381 Marketing I 9
- 70-430 International Management 9
- 88-384 Conflict and Conflict Resolution in International Relations 9

Regional Specialization (1 course)

Complete one course in non-US History, international politics, or literature in a single region of the world. See the list at http://www.cit.cmu.edu/global/courses_degrees.html below for examples (Note: Please consult with the Global Engineering director before planning your course schedule, as some course information may have changed).

Ethics (1 course)

Any ethics course that provides some exposure to international ethics issues such as:

- 70-332 Business, Society and Ethics 9
- 80-136 Social Structure, Public Policy & Ethics 9
- 80-243 Business Ethics 6

Or approved equivalent.

Modern Languages

Demonstration of basic competency in a foreign language via one of the three options listed below:

- Complete one (1) Modern Languages course at the 200 level, with a minimum grade of C, or
- Achieve a score of 4 or higher in one foreign language Advanced Placement examination, or
- Demonstrate equivalent proficiency to the satisfaction of the Department of Modern Languages

Study/Work Abroad

Study or engineering internship work abroad for a semester or a summer. The region visited should be consistent with the language and regional culture/history studied.

Manufacturing Engineering Designated Minor

Burak Ozdoganlar, Director Office: Scaife Hall 312

The Designated Minor in Manufacturing Engineering provides the student with a background in the basic engineering issues that arise in all manufacturing enterprises, from product design through production processes, to issues in marketing and management.

Faculty Advisors

A faculty member from each department will serve as the faculty advisor for the students who are pursuing the minor degree in their respective departments. Current faculty advisors are:

- Chemical Engineering — Lorenz Biegler
- Civil and Environmental Engineering — Susan Finger
- Electrical and Computer Engineering — Bruce H. Krogh
- Engineering and Public Policy — Deanna Matthews
- Materials Science and Engineering — Robert Heard
- Mechanical Engineering — Burak Ozdoganlar

Course Requirements

This minor requires a total of five courses comprising of two core courses and three technical electives.

Two Core Courses:

The two core courses vary depending on the student’s major. MSE majors must take the following core courses:

- 27-401 MSE Capstone Course I 12
- 27-402 MSE Capstone Course II 12

Non-MSE majors must instead take the following core courses:

- 24-341 Manufacturing Sciences 9
- 27-357 Introduction to Materials Selection 6

Note: Instructor’s permission to waive the prerequisites for the core courses will be considered for students pursuing the Manufacturing Engineering Designated Minor.

Technical Electives:

A total of three courses must be selected from at least two of the following categories. Courses taken to fulfill requirements for the student’s major, other than technical elective requirements, cannot be used to fulfill this requirement.

Real-Time Systems and Robotics

- 16-721 Learning-based Methods in Vision 12
- 16-741 Mechanics of Manipulation 12
- 18-348 Embedded Systems Engineering 12
- 18-474 Embedded Control Systems 12
- 18-549 Embedded Systems Design 12
- 18-649 Distributed Embedded Systems 12

Design, Materials and Processes

- 24-483 Design for Manufacture and the Environment 12
- 27-322 Powder Processing of Materials 9
- 27-421 Processing Design 6
- 27-592 Solidification Processing 9
Materials Science and Engineering Designated Minor

Michael E. McHenry, Director
Office: Roberts Engineering Hall 243

The Designated Minor in Materials Science and Engineering provides the CIT student with a background in the field of Materials Science and Engineering. This minor is open to all CIT students, with the exception of MSE majors. All required and elective courses are taught within the MSE Department.

Course Requirements

The minor requires a minimum of 45 units, with two semester long required courses (the first being a sequence of two minis).

Prerequisites

Students wishing to take the MSE minor must have prerequisite thermodynamics and transport courses. The prerequisite MSE courses may be substituted for by a thermodynamics and transport course in another engineering discipline.

Core Courses (21 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-211</td>
<td>Structure of Materials (Minor Option)</td>
<td>6</td>
</tr>
<tr>
<td>27-212</td>
<td>Defects in Materials (Minor Option)</td>
<td>6</td>
</tr>
<tr>
<td>27-217</td>
<td>Phase Relations and Diagrams</td>
<td></td>
</tr>
</tbody>
</table>

The laboratories with these courses are not required as core but will be counted as elective units if desired.

Elective Courses (24 units minimum)

The student must select a minimum of 24 units from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-201</td>
<td>Engineering the Materials of the Future</td>
<td>12</td>
</tr>
<tr>
<td>27-301</td>
<td>Microstructure and Properties I</td>
<td>9</td>
</tr>
<tr>
<td>27-302</td>
<td>Microstructure and Properties II</td>
<td>9</td>
</tr>
<tr>
<td>27-311</td>
<td>Polymeric Biomaterials</td>
<td>9</td>
</tr>
<tr>
<td>27-312</td>
<td>Metallic and Ceramic Biomaterials</td>
<td>9</td>
</tr>
<tr>
<td>27-322</td>
<td>Processing of Metals</td>
<td>9</td>
</tr>
<tr>
<td>27-323</td>
<td>Powder Processing of Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-324</td>
<td>Introduction to Polymer Science and Engineering</td>
<td>9</td>
</tr>
<tr>
<td>27-325</td>
<td>Polymer Physics and Morphology</td>
<td>9</td>
</tr>
<tr>
<td>27-357</td>
<td>Introduction to Materials Selection</td>
<td>6</td>
</tr>
<tr>
<td>27-367</td>
<td>Selection and Performance of Materials</td>
<td>6</td>
</tr>
<tr>
<td>27-582</td>
<td>Phase Transformations in Solids</td>
<td>6</td>
</tr>
<tr>
<td>27-423</td>
<td>Dielectric, Magnetic, Superconducting Properties of Materials &amp; Related Devices</td>
<td>9</td>
</tr>
<tr>
<td>27-432</td>
<td>Electronic and Thermal Properties of Metals, Semiconductors and Related Devices</td>
<td>9</td>
</tr>
<tr>
<td>27-421</td>
<td>Processing Design</td>
<td>6</td>
</tr>
<tr>
<td>27-445</td>
<td>Structure, Properties and Performance Relationships in Magnetic Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-512</td>
<td>Diffraction Methods in Materials Science</td>
<td>9</td>
</tr>
<tr>
<td>27-510</td>
<td>Polymeric Biomaterials</td>
<td>9</td>
</tr>
<tr>
<td>27-511</td>
<td>Introduction to Molecular Biomaterials</td>
<td>12</td>
</tr>
<tr>
<td>27-591</td>
<td>Mechanical Behavior of Materials</td>
<td>6</td>
</tr>
<tr>
<td>27-530</td>
<td>Advanced Physical Metallurgy</td>
<td>9</td>
</tr>
<tr>
<td>27-454</td>
<td>Supervised Reading</td>
<td>6</td>
</tr>
<tr>
<td>27-533</td>
<td>Principles of Growth and Processing of Semiconductors</td>
<td>6</td>
</tr>
<tr>
<td>27-555</td>
<td>Materials Project I</td>
<td>1</td>
</tr>
<tr>
<td>27-565</td>
<td>Nanostructured Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-542</td>
<td>Processing and Properties of Thin Films</td>
<td>9</td>
</tr>
<tr>
<td>27-551</td>
<td>Properties of Ceramics and Glasses</td>
<td>9</td>
</tr>
<tr>
<td>27-566</td>
<td>Special Topics in MSE</td>
<td>9</td>
</tr>
</tbody>
</table>

Supervised Reading: Var.

1 27-202 cannot be used by MSE students to satisfy the requirements of the minor.

2 27-357 cannot be used by MSE students to satisfy the requirements of the minor.

Group A: Materials Science Courses

Each student must take one course from this list of Materials Science courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-202</td>
<td>Defects in Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-357</td>
<td>Introduction to Materials Selection</td>
<td>6</td>
</tr>
<tr>
<td>27-551</td>
<td>Properties of Ceramics and Glasses</td>
<td>9</td>
</tr>
<tr>
<td>27-530</td>
<td>Advanced Physical Metallurgy</td>
<td>9</td>
</tr>
<tr>
<td>42-411</td>
<td>Introduction to Molecular Biomaterials</td>
<td>9</td>
</tr>
</tbody>
</table>

Group B: Solid Mechanics Courses

Each student must take two of the following Solid Mechanics courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-231</td>
<td>Solid Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>or 24-262</td>
<td>Stress Analysis</td>
<td></td>
</tr>
<tr>
<td>12-635</td>
<td>Structural Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 24-351</td>
<td>Dynamics</td>
<td></td>
</tr>
<tr>
<td>24-751</td>
<td>Introduction to Solid Mechanics I</td>
<td>12</td>
</tr>
</tbody>
</table>

Students should check with the director of the program or their faculty advisor for an up-to-date list of relevant courses that will count towards this minor. For more information, please consult the Undergraduate Course Catalog and the current Schedule of Classes.
CIT Minors for Non-Engineering Students

Biomedical Engineering Minor
(for non-engineering students)
Jeffrey O. Hollinger, Director
www.bme.cmu.edu
Campus Office for Student Affairs: Doherty Hall 2100

BME offers a minor program for those students who desire coordinated training in BME but may not have the time to pursue the BME additional major. The Biomedical Engineering Minor is designed to train students to apply engineering techniques to problems in medicine and biology. Emphasis is placed on describing biological organisms as engineering systems and on applying engineering technology to clinical and laboratory situations.

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Biomedical or basic biomedical sciences at either the master’s or Ph.D. level. In addition, some of the courses in BME minor will assist students in preparing for medical school. Students who pursue jobs in biomedical engineering are involved in developing and improving medical devices, automating medical procedures using information technology, characterizing the operation of physiological systems, designing artificial organs, and altering microbes and mammalian cells for the production of useful drugs and chemicals.

The Biomedical Engineering Minor accepts undergraduate students from both within and outside CIT. Students in the minor program can choose from a wide range of electives to build skills in a number of areas of biomedical engineering. Students who wish to complete the Biomedical Engineering Designated Minor should complete the CIT Minor Request Form (http://www.cit.cmu.edu/files/documents/minor_request.pdf) and return it to the Associate Head of the Department of Biomedical Engineering (http://www.bme.cmu.edu/bme/contact.html).

Requirements for non-CIT students: six courses, minimum of 60 units

Electives may be selected from the following:

1. Any Track Gateway, Track Elective or Track Capstone course selected from any of the four Biomedical Engineering tracks. A list of track electives is provided under the BME Additional Major listing in the catalog and is periodically updated on this website.

2. Any course with a 42-xxx or 46-xxx number.

3. 42-203 Biomedical Engineering Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program)**

4. One semester of 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 Honors Research Project, as long as the research project is supervised by a regular or courtesy Biomedical Engineering faculty member and the project is conducted for 9 or more units of credit.

5. Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Notes:

* Select either 06-100 Introduction to Chemical Engineering 12-100 Introduction to Civil and Environmental Engineering, 19-100 Introduction to Electrical and Computer Engineering, 19-101 Introduction to Engineering and Public Policy, 27-100 Engineering the Materials of the Future, or 24-101 Fundamentals of Mechanical Engineering. Note that co-requisites are required for these courses.

# This course cannot be a required course in the student’s major.

+ This course must be a Biomedical Engineering Track Gateway, Track Elective or Track Capstone course that is offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx). The only exception is that 03-232, the biotechnology version of Biochemistry I taught each Spring by the Department of Biological Sciences, is also acceptable, provided students meet the prerequisite and corequisites for that course.

** Priority for enrollment in 42-203 or 03-206 will be given to students who have declared the Additional Major in Biomedical Engineering. If sufficient room in the course remains after all majors have been accommodated in a given semester, students who have declared the Biomedical Engineering Designated Minor will be given the next priority for enrollment. If space still allows, other students will be enrolled.

Engineering Studies Minor
(for non-engineering students)

Kurt Larsen, Director Office: Scaife Hall 110

Carnegie Mellon undergraduate students enrolled in colleges other than engineering can complete a Minor in Engineering Studies in addition to their regular majors. Students pursuing this minor are required to complete courses from at least two different engineering departments in order to assure some breadth of exposure to engineering. In addition, the minor provides students the opportunity to pursue an in-depth concentration in a particular field of engineering.

For the Minor in Engineering Studies, students must complete five engineering courses as follows and must earn a cumulative GPA of 2.00 in these five courses.

Double counting of core courses in student’s primary major is not permitted.

For students declaring this minor after Fall 2011, only up to two EPP courses (including 19-101) can be used toward the minor requirements.

Students interested in EPP coursework should consider the Technology and Policy minor instead. Please note that students need special permission to use an Engineering and Public Policy course (EPP-19-xxx) toward minor requirements.

Requirements

1. Two of the following:

   12-100 Introduction to Civil and Environmental Engineering 12
   18-100 Introduction to Electrical and Computer Engineering 12
   19-101 Introduction to Engineering and Public Policy 12
   24-101 Fundamentals of Mechanical Engineering 12
   27-100 Engineering the Materials of the Future 12
   42-101 Introduction to Biomedical Engineering 12
   06-100 Introduction to Chemical Engineering 12

2. Three courses of at least 9 units each from one or more CIT departments

3. NOTE: The following courses may NOT be included as part of the Minor in Engineering Studies.

   18-200 Emerging Trends in Electrical and Computer Engineering 1
   18-202 Mathematical Foundations of Electrical Engineering 12
   39-200 Business for Engineers 9
   24-201 Engineering Graphics 9
   42-202 Physiology 9
   06-262 Mathematical Methods of Chemical Engineering 12
   24-311 Numerical Methods 12
   19-609 Public Policy and Regulation 9
   19-611 Special Topics: Global Competitiveness: Firms, Nations and Technological Change 12
   19-613 Industries and Technological Innovation: Positions, Paths and Progress 9
   19-680 ETM Seminar on Innovation Management in Practice 3
   19-681 Managerial and Engineering Economics 12
   19-682 The Strategy and Management of Technological Innovation 12
   19-687 Principles and Practices of R&D Management 6
   19-688 Innovation for Energy and the Environment 12
   19-693 Managing and Leading Research and Development 12
   19-699 Special Topics: Institutions Entrepreneurship and Innovation Var.

Technology and Policy Minor
(for non-engineering students)

Deanna H. Matthews, Director Office: Baker Hall 129

The Technology and Policy Minor is administered by the Department of Engineering and Public Policy (EPP) for students who are majoring in areas other than engineering or computer science. The T&P Minor is designed to give students a basic understanding of the interactions between technology,
society and policy and some project experience in problems involving 
technology and policy.

The T&P Minor requires satisfactory completion of a set of six courses 
totaling a minimum of 51 units. These courses are:

- 19-102 EPP Sophomore Seminar 3
- 19-451 EPP Projects 12
- or 19-452 EPP Projects 7
- 33-100 Principles of Economics 9
- 88-223 Decision Analysis and Decision Support Systems 9
- or 88-302 Behavioral Decision Making 9

EPP Technical Electives include courses in CIT, MCS, or SCS that address 
problems at the society-technology interface and the means of analyzing 
these issues. A list of qualifying technical electives is assembled each 
semester and is available from the Associate Department Head for 
Undergraduate Affairs in EPP.

Students interested in the T&P minor should contact the Department of 
Engineering and Public Policy early in their course of study.

Robotics Minor

Howie Choset, Director
Office: NSH 3205
Website: http://www.ri.cmu.edu/education/ugrad_minor.html

As its name suggests, the robotics minor focuses on robotics. It is open to 
students in all colleges of the University. This minor will have a prerequisite: 
basic programming skills, and familiarity with basic algorithms. Typically, 
students get these by taking Principles of Computing (15-110). Students 
should be able to demonstrate programming experience from other courses 
or independent study work.

A central course for the minor is a new one entitled, Introduction to Robotics 
(16-311). This course will give students the big picture of what is going on in 
robotics through topics such as kinematics, mechanisms, motion planning, 
sensor based planning, mobile robotics, sensors, and vision. The minor also 
has two other required courses: (1) a controls class and (2) a manipulation, 
dynamics, or mechanism class. These courses provide students with the 
necessary intuition and technical background to move on to more advanced 
robotics courses.

Students may satisfy the elective requirement by taking an upper level 
Robotics Institute course and an independent research project under 
Mechanical Engineering Project (24-391) or Honors Research Project 
(39-500). In any event, the student must have course selection approved 
by the director of the minor. In order to be awarded the Minor in Robotics, a 
student must earn a cumulative QPA of 2.0 in these courses.

Prerequisite

The robotics minor will have a prerequisite: knowledge of C language, basic 
programming skills, and familiarity with basic algorithms. Students can 
gain this knowledge by taking 15-122 Principles of Imperative Computation 
(15-110) units.

Required Courses

<table>
<thead>
<tr>
<th>Overview</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Robotics</td>
<td>12</td>
</tr>
</tbody>
</table>

Controls (choose one of the following):

- 24-451 Feedback Control Systems 12
- 18-370 Fundamentals of Control 12
- 16-299 Introduction to Feedback Control Systems (Computer Science) 12

Manipulation (choose one of the following):

- 16-384 Robot Kinematics and Dynamics 12
- 24-355 Kinematics and Dynamics of Mechanisms 9

Electives

Two Electives (chosen from the following): Units

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-601 Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>13-344 Machine Learning in Practice</td>
<td>12</td>
</tr>
<tr>
<td>15-381 Artificial Intelligence: Representation and Problem Solving</td>
<td>9</td>
</tr>
<tr>
<td>15-385 Computer Vision</td>
<td>9</td>
</tr>
<tr>
<td>15-462 Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>15-491 Special Topic: CMRoboBots: Creating Intelligent Robots</td>
<td>9</td>
</tr>
<tr>
<td>15-494 Special Topic: Cognitive Robotics</td>
<td>12</td>
</tr>
<tr>
<td>16-264 Humanoids</td>
<td>12</td>
</tr>
<tr>
<td>16-382 Mobile Robot Programming Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>16-421 Vision Sensors</td>
<td>12</td>
</tr>
<tr>
<td>18-342 Fundamentals of Embedded Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-348 Embedded Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-349 Embedded Real-Time Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-349 Embedded Systems Design</td>
<td>12</td>
</tr>
</tbody>
</table>

Double-Counting Restriction

Courses in the Robotics Minor may not be counted towards another SCS 
minor.
Biomedical Engineering Overview

Biomedical engineers advance the understanding of living systems and the quality of human health, by integrating powerful technologies derived from traditional scientific and engineering disciplines with the knowledge of biology, medicine, and clinical medicine. Biomedical engineering (BME) education at Carnegie Mellon reflects the belief that a top biomedical engineer must be deeply trained in both the traditional engineering practice and biomedical sciences, in order to apply techniques of science, mathematics, and technology effectively to medical and biological problems. Emphasis of the training is placed on analyzing biological organisms as engineering systems and applying engineering approaches to clinical and biomedical research problems.

Although Carnegie Mellon does not have a medical school, it leverages extensive collaborations with researchers and physicians in the University of Pittsburgh Medical Center, the Western Pennsylvania/Allegheny General Hospital System, and the Children’s Hospital System in Pittsburgh. This collaborative approach both within and outside Carnegie Mellon, combined with a rigorous engineering education, confers a distinct advantage to BME graduates and allows them to shape the future of BME in industrial, clinical, and academic settings.

The BME undergraduate curriculum at Carnegie Mellon is structured to provide both breadth and depth. The current system offers an “additional major B.S. degree” in official language. Undergraduate students who elect BME as a major must also declare a major in one of the traditional engineering disciplines: Chemical Engineering, Civil Engineering, Electrical & Computer Engineering, Materials Science & Engineering, or Mechanical Engineering. This ensures that Carnegie Mellon BME students gain as much engineering expertise as students who pursue a traditional engineering major, while at the same time developing a deep understanding of biomedical engineering specialties. The curriculum is demanding due to its interdisciplinary nature, but is quite feasible and highly rewarding to motivated students.

BME Major Curriculum

The BME major curriculum takes advantage of overlapping elective and required courses with the traditional engineering majors, such that the additional major can be obtained with a modest increase in the total number of units required at graduation. The BME curriculum is comprised of three parts: the BME core, the BME tracks, and the BME capstone design course. The core exposes BME students to multiple facets of BME and builds a common background in life sciences. The track system allows students to select and build depth in a particular aspect of BME that parallels one or more traditional engineering disciplines: Civil Engineering, Chemical Engineering, Electrical & Computer Engineering, and Materials Science & Engineering. Each track starts with a gateway course that provides a common foundation, followed by three electives. Collaborations among the CIT departments allow these courses to be taught by experts, whether they are formally appointed in BME or in a partner department. A general biomedical engineering track is also available for those students intending on pursuing graduate studies or medical school. In addition, a self-designed biomedical engineering track allows students to pursue specific areas not covered by the above tracks.

The BME program culminates in the BME Design courses during the senior year. These courses organize BME students of different traditional engineering backgrounds into teams, to tackle industry- and clinic-sponsored projects for products and product concepts relevant to human health and life sciences. These projects have resulted in patent applications and licensing opportunities.

Course Requirements for the Additional Major Degree

In order to graduate, a student must meet three sets of requirements: for Biomedical Engineering (BME), for a partner traditional engineering department, and for the CIT General Education (http://www.cit.cmu.edu/current_students/services/general_education.html) sequence. The Quality Point Average for BME core, track and design courses must be 2.00 or better. No Biomedical Engineering (42-xxx) course may be taken on a pass/fail basis. No course from any department taken on a pass/fail or audit basis may be counted toward the requirements of Additional Major in Biomedical Engineering or the Designated Minor in Biomedical Engineering.

The course requirements for the BME portion of the additional major are as follows:

Core Courses (all required)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-101</td>
<td>Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-201</td>
<td>Professional Issues in Biomedical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>42-203</td>
<td>Biomedical Engineering Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>42-401</td>
<td>Foundation of BME Design</td>
<td>3</td>
</tr>
<tr>
<td>42-402</td>
<td>BME Design Project</td>
<td>9</td>
</tr>
</tbody>
</table>

* Also known as 03-206 for Health Professions Program students.

Tracks (Completion of one track is required)

- Biomaterials and Tissue Engineering (BMTE (http://www.bme.cmu.edu/bsporg/BMTE.html))
- Biomechanics (BMEC (http://www.bme.cmu.edu/bsprog/BMEC.html))
- Biomedical Signal and Image Processing (BSIP (http://www.bme.cmu.edu/bsprog/BSIP.html))
- Cellular and Molecular Biotechnology (CMBT (http://www.bme.cmu.edu/bsprog/CMBT.html))
- General Biomedical Engineering (GBME (http://www.bme.cmu.edu/bsprog/GBME.html))
- Self-Designed Biomedical Engineering (SBME (http://www.bme.cmu.edu/bsprog/SBME.html))

Biomaterials and Tissue Engineering (BMTE) Track

The BMTE track addresses fundamental issues at the interface of materials science, biology and engineering. The coursework includes the design and development of materials for biological applications, the engineering of new tissues from isolated cells including stem cells, and techniques for measuring the outcome of biomaterials and biological interactions. Students will understand how materials, cells, tissues, and organ systems interact and how such interactions affect the organization and functional states of cells and tissues. The knowledge will also direct rational, practical therapeutic solutions.

The BMTE track is ideal for those interested in combining the training of BME with Materials Science & Engineering, or with Chemical Engineering. Professional opportunities are found in the biotechnology, medical device and biopharmaceutical industries or further studies in graduate or medical school. Exciting opportunities are expected for engineers trained in the development and production of biological materials, medical devices, and combination drug-cell-material devices.

In addition to the general BME requirements (http://www.bme.cmu.edu/bsprog), students in the BMTE Track must take the following combination of courses:
• One (1) BMTE Gateway course
• One (1) Required BMTE elective
• Two (2) other Electives (either one of the two options)
  1. One (1) BMTE Elective (either Required or Additional) and one (1) Restricted Elective
  2. Two (2) Additional BMTE Electives

BMTE Gateway Course#

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-221</td>
<td>Biochemistry I- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>03-232</td>
<td>Biochemistry I- Spring</td>
<td>Spring</td>
<td>9</td>
</tr>
</tbody>
</table>

# Note that only 03-232 satisfies Chemistry Engineering course requirements. Either 03-231 or 03-232 satisfies Materials Science & Engineering requirements.

BMTE Electives

Required BMTE Electives (must take one of the following)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-419</td>
<td>Biomedical Host Interactions- Fall</td>
<td>Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-520</td>
<td>Tissue Engineering (Spring)</td>
<td>Spring</td>
<td>12</td>
</tr>
</tbody>
</table>

Additional BMTE Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-240</td>
<td>Cell Biology- Spring</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>or 09-228</td>
<td>Organic Chemistry II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42-411</td>
<td>Introduction to Molecular Biomaterials- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-509</td>
<td>Stem Cell Engineering- Spring, every other year</td>
<td>Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-530</td>
<td>Biological Transport and Drug Delivery- Spring</td>
<td>Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-570</td>
<td>Molecular and Micro-scale Polymeric Biomaterials in Medicine- Spring</td>
<td>Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-620</td>
<td>Engineering Molecular Cell Biology- Fall</td>
<td>Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-643</td>
<td>Microfluidics Intermediate- Intermediate</td>
<td>Spring</td>
<td>12</td>
</tr>
<tr>
<td>24-615</td>
<td>Microfluidics- Spring, Intermediate</td>
<td>Spring</td>
<td>12</td>
</tr>
</tbody>
</table>

2 Note that either 09-217 or 09-218 (offered in the Spring), but not both, may be counted as a BMTE Elective.

• Chemical Engineering requirement

Restrictive Elective Courses (choose at most one)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-531</td>
<td>Computational Methods in Biomedical Engineering- Spring</td>
<td>Spring</td>
<td>12</td>
</tr>
<tr>
<td>42-460</td>
<td>Surgery for Engineers- Fall / Spring</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699A</td>
<td>Technological Innovation in Biomedical Engineering - Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699C</td>
<td>Basic Statistics for Biomedical Research - Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-xxx</td>
<td>BMME Research *</td>
<td>Var.</td>
<td></td>
</tr>
<tr>
<td>39-500</td>
<td>Honors Research Project</td>
<td>Var.</td>
<td>-1</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit.

Some Special Topics and newly offered or intermittently offered courses may be acceptable as BMTE track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as BMTE track electives.

Sample schedules can be found on the BMTE (http://www.bme.cmu.edu/bsmtp/BMTE.html) page on the BMTE website.

Biomechanics (BMEC) Track

Biomechanics refers to the application of principles of solid, fluid, and continuum mechanics to the study of the structure, function, and behavior of biological and medical systems under the influence of mechanical forces. Biomechanics draws on advances in biology, physics and applied mathematics, as well as new technologies in mechanical probing, imaging, and scientific computing. Biomechanics models provide qualitative descriptions of molecule, cell, tissue, organ, and whole organism behavior under mechanical stimuli, and are employed to characterize human health, disease, and injury. Biomechanics models are also used in the design of rehabilitative devices and strategies.

The BMEC track is ideally suited to the combined training of BME and Mechanical Engineering or Civil & Environmental Engineering, which provides a strong core of the underlying physical principles and relevant non-BME applications. This track is also compatible with Electrical & Computer Engineering particularly for those interested in biomedical applications of robotics. A broad background in biomechanics enables students to work in the medical device industry or as a rehabilitation engineer. It also provides the ability to conduct fundamental biomechanics modeling and experimental research, or to pursue advanced education in medical or graduate schools.

In addition to the general BME requirements (http://www.bme.cmu.edu/bsprog), students in the BMEC Track must take at least one of the following

• One (1) BMEC Gateway Course
• One (1) Required BMEC Elective
• Two (2) other Electives (either one of the two options)
  1. One (1) BMEC Elective (either Required or Additional) and one (1) Restricted Elective 2. Two (2) BMEC Electives (either Required or Additional)

BMEC Gateway Course

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-231</td>
<td>Fluid Mechanics</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>06-261</td>
<td>Fluid Mechanics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-355</td>
<td>Fluid Mechanics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Note that 24-231 Fluid Mechanics satisfies Mechanical Engineering course requirements, 06-261 Fluid Mechanics satisfies Chemical Engineering course requirements, and 12-355 Fluid Mechanics satisfies Civil & Environmental Engineering course requirements.

BMEC Electives

Required BMEC Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-341</td>
<td>Introduction to Biomechanics- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-441</td>
<td>Cardiovascular Biomechanics- Spring, every other year</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-642/24-619</td>
<td>Biological Fluid Mechanics- Spring, every other year</td>
<td>Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-645/24-655</td>
<td>Cellular Biomechanics- Spring, every other year</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-646/24-657</td>
<td>Molecular Biomechanics- Spring, every other year</td>
<td>Fall</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional BMEC Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-412/03-439</td>
<td>Introduction to BioPhysics- Fall</td>
<td>Fall</td>
<td>10</td>
</tr>
<tr>
<td>42-344</td>
<td>Medical Devices- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-447</td>
<td>Rehabilitation Engineering- Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-640/24-658</td>
<td>Computational Bio-Modeling and Visualization- Spring</td>
<td>Spring</td>
<td>12</td>
</tr>
<tr>
<td>42-641/24-676</td>
<td>Bio Inspired Robotics- Fall</td>
<td>Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-643/24-65</td>
<td>Microfluidics Intermediate</td>
<td>Winter</td>
<td>12</td>
</tr>
<tr>
<td>42-647</td>
<td>Introduction to Continuum Biomechanics- Spring</td>
<td>Spring</td>
<td>12</td>
</tr>
</tbody>
</table>

Restrictive Elective Courses (choose at most one)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-531</td>
<td>Computational Methods in Biomedical Engineering- Spring</td>
<td>Spring</td>
<td>12</td>
</tr>
<tr>
<td>42-660</td>
<td>Surgery for Engineers- Fall / Spring</td>
<td>Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-699A</td>
<td>Technological Innovation in Biomedical Engineering - Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699C</td>
<td>Basic Statistics for Biomedical Research - Fall</td>
<td>Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-xxx</td>
<td>BMME Research *</td>
<td>Var.</td>
<td></td>
</tr>
<tr>
<td>39-500</td>
<td>Honors Research Project</td>
<td>Var.</td>
<td>-1</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the BMTE (http://www.bme.cmu.edu/bsprog/BMTE.html) page on the BMTE website.

Biomedical Signal and Image Processing (BSIP) Track

Biomedical signal and image processing is the study of bio/medical phenomena based on the information embedded in sensor-detected signals, including digital images and nerve electrical pulses. It draws upon advances in signal processing, optics, probe chemistry, electrical sensors, molecular biology, and machine learning, to provide answers to biological and medical questions. Students in this track will gain understanding of the technologies involved in acquiring signals and images, the mathematical principles underlying the processing and analysis of signals, and the applications of signal/image processing in basic research and medicine.

This track aligns most naturally with a combined training of BME and Electrical & Computer Engineering. A biomedical signal and image processing specialist will have a broad background to enter companies developing technologies for medical imaging or smart prosthetics, to pursue a career in basic biomedical research by going to a graduate school, or to enter a medical school to pursue a medical career particularly in radiology, neurology/neurosurgery, and pathology.

In addition to the general BME requirements (http://www.bme.cmu.edu/bsprog), students in the BSIP Track must take the following combination of courses:

• One (1) BMEC Gateway Course
• One (1) Required BMEC Elective
• Two (2) other Electives (either one of the two options)
  1. One (1) BMEC Elective (either Required or Additional) and one (1) Restricted Elective 2. Two (2) BMEC Electives (either Required or Additional)
• One (1) BSIP Gateway course
• One (1) Required BSIP elective
• Two (2) other Electives (either one of the two options)

1. One (1) BSIP Electives (either Required or Additional) and one (1) Restricted Elective 2. Two (2) BSIP Electives (either Required or Additional)

**BSIP Gateway Course**
18-290 Signals and Systems – Fall/Spring

**BSIP Electives**
Required BSIP Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-431/42-496</td>
<td>Introduction to Biomedical Imaging and Image Analysis - Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-632</td>
<td>Neural Signal Processing</td>
<td>12</td>
</tr>
<tr>
<td>42-699E</td>
<td>Neural Data Analysis - Fall</td>
<td>12</td>
</tr>
</tbody>
</table>

Additional BSIP Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-534</td>
<td>Biological Imaging and Fluorescence Spectroscopy</td>
<td>9</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation - Spring</td>
<td>9</td>
</tr>
<tr>
<td>18-491</td>
<td>Fundamentals of Signal Processing - Fall</td>
<td>12</td>
</tr>
<tr>
<td>or 18-792</td>
<td>Advanced Digital Signal Processing</td>
<td></td>
</tr>
<tr>
<td>42-426</td>
<td>Biosensors and BioMEMS - Spring</td>
<td></td>
</tr>
<tr>
<td>42-531</td>
<td>Rehabilitation Engineering - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-580</td>
<td>Biosensorization</td>
<td>12</td>
</tr>
<tr>
<td>42-640/24-658</td>
<td>Computational Bio-Modeling and Visualization</td>
<td></td>
</tr>
<tr>
<td>42-735</td>
<td>Medical Imaging Analysis - Spring</td>
<td></td>
</tr>
</tbody>
</table>

• Note that either 18-491 or 18-792 (offered in Spring), but not both, may be counted as a BSIP Elective.

**Restrictive Elective Courses (choose at most one)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-531</td>
<td>Computational Methods in Biomedical Engineering - Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-660</td>
<td>Surgery for Engineers - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699A</td>
<td>Biomedical Engineering Technology in Biomedical Engineering - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699C</td>
<td>Basic Statistics for Biomedical Research - Fall</td>
<td></td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Research</td>
<td>Var.</td>
</tr>
<tr>
<td>39-500</td>
<td>BME Research</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honors Research Project</td>
<td>-1</td>
</tr>
</tbody>
</table>

1. The 42-x00 research project (42-200-300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the BSIP (http://www.bme.cmu.edu/bsipprog/BSIPhtml) page on the BME website.

**Cellular and Molecular Biotechnology (CMBT) Track**

The CMBT track emphasizes fundamentals and applications of biochemistry, biophysics, and cell biology. Students in this track will acquire a deep understanding of the molecular and cellular bases for life processes, quantitative modeling skills needed to develop biotechnologies based on live cell cultures, as well as technologies that exploit the unique properties of biomolecules in non-biological settings. One of the unique characteristics of this track is an emphasis on processes and structures occurring on the nanometer to micrometer size scale range.

The CMBT track is ideally suited to the combined training in BME and Chemical Engineering, which provides a strong core of chemistry and molecular processing principles. The track may also suit students pursuing combined BME/Mechanical Engineering or BME/Civil and Environmental Engineering training who have an interest in the molecular sciences. The CMBT track prepares students for careers or advanced education involving biopharmaceutical manufacture, pharmacology, medical diagnostics, biosensors, drug delivery devices, and biological aspects of environmental engineering.

In addition to the general BME requirements (http://www.bme.cmu.edu/bsipprog), students in the CMBT Track must take the following combination of courses:

• One (1) CMBT Gateway course
• One (1) Required CMBT Elective
• Two (2) other Electives (either one of the two options)

1. One (1) CMBT Elective (either Required or Additional) and one (1) Restricted Elective 2. Two (2) CMBT Electives (either Required or Additional)

**CMBT Gateway Course**
03-231 Biochemistry I (units) – Fall
03-232 Biochemistry I (units) – Spring

*Note that only 03-232 satisfies Chemistry Engineering course requirements, either 03-231 or 03-232 satisfies Materials Science & Engineering requirements.

**CMBT Electives**
Required CMBT Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-321</td>
<td>Cellular and Molecular Biotechnology - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-530</td>
<td>Biological Transport and Drug Delivery - Fall</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional CMBT Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-240</td>
<td>Cell Biology - Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-426</td>
<td>Biosensors and BioMEMS - Spring</td>
<td></td>
</tr>
<tr>
<td>42-509</td>
<td>Stem Cell Engineering - Spring</td>
<td></td>
</tr>
<tr>
<td>42-620</td>
<td>Engineering Molecular Cell Biology - Fall</td>
<td></td>
</tr>
<tr>
<td>42-606/6-622</td>
<td>Bioprocess Design - Spring, intermittent</td>
<td></td>
</tr>
<tr>
<td>42-643</td>
<td>Microfluidics Intermittent- Spring, intermittent</td>
<td></td>
</tr>
<tr>
<td>42-645/645A</td>
<td>Cellular Biomechanics-Spring, every other year</td>
<td></td>
</tr>
<tr>
<td>42-646/646B</td>
<td>Molecular Biomechanics-Spring, every other year</td>
<td></td>
</tr>
</tbody>
</table>

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

**Restrictive Elective Courses (choose at most one)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-531</td>
<td>Computational Methods in Biomedical Engineering - Fall</td>
<td>12</td>
</tr>
<tr>
<td>42-660</td>
<td>Surgery for Engineers - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699A</td>
<td>Biomedical Engineering Technology in Biomedical Engineering - Fall</td>
<td>9</td>
</tr>
<tr>
<td>42-699C</td>
<td>Basic Statistics for Biomedical Research - Fall</td>
<td></td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Research</td>
<td>Var.</td>
</tr>
<tr>
<td>39-500</td>
<td>BME Research</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honors Research Project</td>
<td>-1</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200-300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit.

Sample schedules can be found on the CMBT (http://www.bme.cmu.edu/bsipprog/CMBT.html) page on the BME website.

**General Biomedical Engineering (GBME) Track**

The GBME track provides more general or mixed training in BME compared to other tracks, and is suitable for students intending on pursuing medical or graduate school. Students are strongly encouraged to consult the advisor(s) and tailor the electives according to their career plans.

In addition to the general BME requirements (http://www.bme.cmu.edu/bsipprog), students in the GBME track must take one gateway course (03-232 Biochemistry I counts as a gateway course), in addition to three elective courses from any of the other four BME tracks or any other 42-5xx or 42-6xx courses.**

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

**The 42-x00 research project (42-200-300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit. Students may count EITHER 42-630 BME Research OR 42-660 Surgery for Engineers as a track elective. Students MAY NOT count both research and Surgery for Engineers as track electives.

**Self-Designed Biomedical Engineering (SBME) Track**

The SBME track is aimed at helping highly motivated students who have a strong sense of career direction that falls beyond the scopes of regular BME tracks. Students taking SBME track must fulfill all the core BME requirements, but are allowed to design the “track” portion of the curriculum. Example areas include biomedical robotics, neural engineering, and computational biomedical engineering.
The SBME track is fundamentally different from the GBME track. Whereas the GBME track increases breadth and may include only courses that are already associated with the four other defined tracks, the SBME track provides depth while allowing students to choose courses from across the University.

Requirements

1. Students wishing to pursue a self-designed track should first consult the Chair of the BME Undergraduate Affairs Committee (UAC), Prof. Robert Tilton, for initial feedback and guidance. A SBME track proposal must be submitted to the UAC at least three weeks prior to Pre-Registration during the spring of the sophomore year. The proposal must include:
   - The four courses to be included in the track, including information on when these courses are expected to be taken.
   - Catalog descriptions of the four courses.
   - A justification of how these courses represent a coherent, BME-relevant theme.

2. All four courses in the SBME track must represent a coherent theme that is relevant to Biomedical Engineering (e.g., neuroengineering, medical robotics, computational biomedical engineering, etc.).

3. At least one course in the track must be judged by the Biomedical Engineering Undergraduate Affairs Committee (UAC) to have significant biological or medical content.

4. Students may count EITHER 42-660 Surgery for Engineers (units) or 42-x00 Biomedical Engineering Research project (at least 9 units), but not both, as fulfilling one track elective. The research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 Honors Research Project) must be on a BME topic supervised or co-supervised by a BME faculty member and conducted for 9 or more units of credit.

5. Once approved, the UAC Chair and the student will sign a contract listing the theme and the four courses comprising the SBME. The contract will be placed in the student’s BME curriculum progress file.

6. In the event that course scheduling issues beyond the student’s control prevent that student from completing an approved self-designed track, the student may:
   - petition the UAC to substitute a different course that fits the track theme or
   - petition the UAC to be credited for the SBME track if he/she completes one of the originally proposed SBME track courses, or two of the originally proposed SBME courses plus Surgery for Engineers (9 units) or Biomedical Engineering Research (at least 9 units).

UAC contacts are Prof. Robert Tilton (committee chair), and Prof. Conrad Zapanta (BME Associate Head).

Minor in Biomedical Engineering

Conrad M. Zapanta, Ph.D.

Campus Office for Student Affairs: Doherty Hall 2100

BME offers a minor program for those students who desire coordinated training in BME but may not have the time to pursue the BME additional major. The Biomedical Engineering Minor is designed to train students to apply engineering techniques to problems in medicine and biology. Emphasis is placed on describing biological organisms as engineering systems and on applying engineering technology to clinical and laboratory situations.

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Biomedical engineering or basic biomedical sciences at either the master’s or Ph.D. level. In addition, some of the courses in BME minor will assist students in preparing for medical school. Students who pursue jobs in biomedical engineering are involved in developing and improving medical devices, automating medical procedures using information technology, characterizing the operation of physiological systems, designing artificial organs, and altering microbes and mammalian cells for the production of useful drugs and chemicals.

The Biomedical Engineering Minor accepts undergraduate students from both within and outside CIT. Students in the minor program can choose from a wide range of electives to build skills in a number of areas of biomedical engineering. Students who wish to complete the Biomedical Engineering
DAHL, KRIS N., Associate Professor of Biomedical Engineering, Chemical Engineering, and Materials Science & Engineering – Ph.D., University of Pennsylvania, 2004;.

DOMACH, MICHAEL M., Professor of Chemical Engineering and Biomedical Engineering – Ph.D., Cornell University, 1983;.

FEDDER, GARY K., Howard M. Wilkoff Professor, Institute for Complex Engineering Systems, Biomedical Engineering, Electrical & Computer Engineering, Robotics Institute – Ph.D., University of California, Berkeley, 1994;.

FEINBERG, ADAM W., Assistant Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., University of Florida, 2004;.

GEYER, HARMUT, Assistant Professor, Robotics Institute and Biomedical Engineering – Ph.D., Friedrich-Schiller-University of Jena, Germany, 2005;.

HO, CHIEN, Professor of Biological Sciences and Biomedical Engineering – Ph.D., Yale University, 1961;.

HOLLINGER, JEFFREY O., Professor of Biomedical Engineering and Biological Sciences – D.D.S. and Ph.D., University of Maryland, 1973 & 1981;.

JARAMAZ, BRANISLAV, Associate Research Professor, Robotics Institute and Biomedical Engineering – Ph.D., Carnegie Mellon University, 1992;.

KANADE, TAKEO, U.A. and Helen Whitaker University Professor, Robotics Institute and Biomedical Engineering – Ph.D., Kyoto University, 1974;.

KOVAČEVIĆ, JELENA, Professor of Biomedical Engineering and Electrical & Computer Engineering – Ph.D., Columbia University, 1991;.

LEDUC, PHILIP R., Professor of Mechanical Engineering, Biomedical Engineering, and Biological Sciences – Ph.D., Johns Hopkins University, 1999;.

LOESCHE, MATHIAS, – Professor of Physics and Biomedical Engineering, Ph.D.; Carnegie Mellon, Technical University of Munich, 1986–.

MANDAL, MAUMITA, Assistant Professor of Chemistry and Biomedical Engineering – Ph.D., Ctr for Cellular & Molecular Biology, Hyderabad, India, 2001;.

MCCHERY, MICHAEL E., Professor of Materials Science & Engineering and Biomedical Engineering – Ph.D., Massachusetts Institute of Technology, 1988;.

MOURA, JOSE M. F., Professor of Electrical & Computer Engineering and Biomedical Engineering – Ph.D., Massachusetts Institute of Technology, 1975;.

MURPHY, ROBERT F., Ray and Stephanie Lane Professor of Computational Biology and Professor of Biological Sciences, Biomedical Engineering, and Machine Learning – Ph.D., California Institute of Technology, 1980;.

OZDOGANLAR, BURAK, Associate Professor of Mechanical Engineering, Biomedical Engineering and Materials Science & Engineering – Ph.D., University of Michigan, 1999;.

PRZYBICYNIEN, TODD M., Professor of Biomedical Engineering and Chemical Engineering – Ph.D., California Institute of Technology, 1989;.

RABIN, YoED, Professor of Mechanical Engineering and Biomedical Engineering – D.Sc., Technion – Israel Institute of Technology, 1994;.

RIVIERE, CAMERON N., Associate Research Professor, Robotics Institute and Biomedical Engineering – Ph.D., Johns Hopkins University, 1995;.

ROHDE, GUSTAVO K., Assistant Professor of Biomedical Engineering – Ph.D., University of Maryland, 2005;.

RUSSELL, ALAN J., Highmark Distinguished Career Professor, Institute of Complex Engineering Systems and Biomedical Engineering – Ph.D., University of London; Carnegie Mellon, 1987–.

SCHNEIDER, JAMES W., – Professor of Chemical Engineering and Biomedical Engineering, Ph.D.; Carnegie Mellon, University of Minnesota, 1998–.

SHIMADA, KENJI, Theodore Ahrens Professor in Engineering – Ph.D., Massachusetts Institute of Technology, 1993;.

SITTI, METIN, Professor, Mechanical Engineering, Biomedical Engineering, Electrical & Computer Engineering, Institute of Complex Engineering Systems, and Robotics Institute – Ph.D., Tokyo University, 1999;.

STETTEN, GEORGE D., Research Professor, Robotics Institute and Biomedical Engineering – MD/Ph.D., State University of New York Syracuse Health Center, 1991, and University of North Carolina, 2000;.

TILTON, ROBERT D., Professor of Biomedical Engineering and Chemical Engineering – Ph.D., Stanford University, 1991;.

VANBRIESEN, JEANNE M., Professor of Civil & Environmental Engineering and Biomedical Engineering – Ph.D., Northwestern University, 1998;.

WAGGONER, ALAN S., Professor of Biological Sciences and Biomedical Engineering – Ph.D., University of Oregon, 1969;.

WANG, YU-LI, Mehrabian Professor and Head of Biomedical Engineering – Ph.D., Harvard University, 1980;.

WASHBURN, NEWELL R., Associate Professor of Biomedical Engineering, Chemistry, and Materials Science & Engineering – Ph.D., University of California, Berkeley, 1998;.

WEISS, LEE E., Research Professor, Robotics Institute, Biomedical Engineering, and Materials Science & Engineering – Ph.D., Carnegie Mellon University, 1984;.

YANG, GE, Assistant Professor, Biomedical Engineering and Lane Center for Computational Biology – Ph.D., University of Minnesota, 2004;.

YU, BYRON, Assistant Professor of Biomedical Engineering and Electrical & Computer Engineering – Ph.D., Stanford University, 2007;.

ZAPANTA, CONRAD M., Associate Teaching Professor and Associate Head of Biomedical Engineering – Ph.D., The Pennsylvania State University, 1997;.

ZAPPE, STEFAN, Assistant Professor of Biomedical Engineering – Ph.D., Technical University of Berlin, 2002;.

ZHANG, YONGJIE JESSICA, Assistant Professor of Mechanical Engineering and Biomedical Engineering – Ph.D., University of Texas at Austin, 2005;.
Department of Chemical Engineering

Andrew Gellman, Head
Office: Doherty Hall 1107

Chemical engineering is a broad discipline based on chemistry, mathematics, physics and biology that applies the principles of engineering science and process systems engineering to the development and commercialization of new products and processes. Engineering science provides experimental and theoretical models for predicting the behavior of fluid flow and heat transfer in materials and biological systems, as well as chemical reactions and mass transfers that take place in multi-component mixtures. Process systems engineering provides methodologies for the systematic design and analysis of processes, including their control, safety, and environmental impact. The department emphasizes the basic principles of engineering science and process systems engineering through problem solving, and it strives to broaden the experience of students by offering a significant number of electives, undergraduate research projects, an integrated masters degree, industrial internships and study abroad programs, all of which benefit from our strong industrial ties.

A career in chemical engineering offers challenging and well-compensated positions in a wide variety of growth industries. Graduates may supervise the operation of chemical plants, redesign chemical processes for pollution prevention, or be involved in the research and development of new products or processes in high technology areas. These activities require knowledge of chemical reactions and catalysis, separation technologies and energy recovery systems, all of which are thoroughly presented in our curriculum. In the petroleum industry, for example, our national need for fuels demands well-trained chemical engineers in catalysis. A significant number of chemical engineers are also hired by industries associated with colloids (fine particles), polymers (plastics and resins), and coatings (e.g., paint, integrated circuits). Opportunities exist in biotechnology, the computer industry, environmental firms, and consulting companies. Other examples include the processing of advanced polymeric systems, thin films for the semiconductor and data storage industry, and chip fabrication. A growing number of consulting companies hire chemical engineers to develop computer software for the simulation and real-time optimization of chemical processes, for predicting how toxic chemicals are dispersed and degraded in soils and in the atmosphere, and for evaluating the economic feasibility of industrial projects. The diversity of career opportunities arises from the depth and breadth of the curriculum. For instance, the pharmaceutical industry recruits chemical engineers who possess a combined expertise in process engineering and biochemistry/molecular biology.

The curriculum emphasizes the fundamentals of physical, chemical, and biological phenomena, mathematical modeling, exposure to biotechnology and problem solving techniques. These provide rigorous preparation for immediate employment after graduation, or a strong basis for graduate school. The depth and breadth of coursework makes chemical engineering an excellent major for students interested in either medical or business schools. Computing is integrated throughout the curriculum, and extensive use is made of mathematical modeling and simulation software in the department’s Computational Laboratory. The Robert Rothfus Laboratory and Lubrizol Analytical Laboratory feature state-of-the-art experiments that illustrate applications in safety, environmental, product development, and computerized data acquisition and control.

Educational Objectives and Outcomes

The objectives for the program are that graduates of the department will obtain employment or attend graduate school, will advance in their chosen careers, and will be productive and fulfilled professionals throughout their careers. The curriculum and programs are developed to prepare students to attain these educational objectives.

Students majoring in chemical engineering learn the science and engineering that govern chemical processing systems. Fundamental principles, problem solving, systems analysis and design, development of self-confidence, and communication skills are emphasized. Students are made aware of modern tools, industrial needs and societal issues. This combination of fundamental knowledge and skills provides a firm foundation for future learning and career growth. The goal of the department is to produce students who will become leaders in their careers. Students who complete the curriculum will have attained the following educational outcomes:

• an ability to apply knowledge of mathematics, science, and engineering
• an ability to design and conduct experiments, as well as to analyze and interpret data

• an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
• an ability to function on multidisciplinary teams
• an ability to identify, formulate, and solve engineering problems
• an understanding of professional and ethical responsibility
• an ability to communicate effectively
• the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
• a recognition of the need for, and an ability to engage in, life-long learning
• a knowledge of contemporary issues
• an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The department offers a number of special programs for students majoring in Chemical Engineering. In addition to the double majors offered by the College of Engineering such as Biomedical Engineering and Engineering & Public Policy, students may choose from a variety of minors in technical areas offered by the College of Engineering. Undergraduate research projects are also available in the areas of bioengineering, complex fluids engineering, environmental engineering, process systems engineering, and catalysis & surface science. Students may participate in study abroad programs during their junior year. In addition to the University program with EPFL in Switzerland and ITESM Monterrey in Mexico, the department provides its own exchange programs with the University of Aachen in Germany and Imperial College in London, Great Britain. The latter two programs are jointly organized with industrial partners, i.e., Bayer Corporation, Air Products & Chemicals, and Procter & Gamble respectively. Students may also participate in Practical Internships for Senior Chemical Engineering Students, a one-year industrial internship program offered between the Junior and Senior years. Finally, qualified students may enroll in our Master of Chemical Engineering program. This degree is typically completed in the fifth year. However, depending on the number of advanced placement courses and course load at Carnegie Mellon, this degree could be awarded during the B.S. graduation, or after one additional semester.

Curriculum

The program in chemical engineering within the Department of Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

First Year

<table>
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<tr>
<th>Fall</th>
<th>Units</th>
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<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
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<tr>
<td>76-xxx</td>
<td>Designated Writing/Expression Course</td>
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<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>06-100</td>
<td>Introduction to Chemical Engineering</td>
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<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
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Total: 44 units

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<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
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<tr>
<td>xx-xxx</td>
<td>Introductory Engineering Elective (other than ChE)</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Physics I for Engineering Students</td>
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<td>xx-xxx</td>
<td>General Education Course</td>
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Total: 43 units

Second Year

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<tbody>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
</tr>
<tr>
<td>06-222</td>
<td>Sophomore Chemical Engineering Seminar</td>
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<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Computer Sci./Physics II</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
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Total: 48.5 units

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<th>Units</th>
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<tbody>
<tr>
<td>06-261</td>
<td>Fluid Mechanics</td>
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<tr>
<td>06-262</td>
<td>Mathematical Methods of Chemical Engineering</td>
</tr>
<tr>
<td>09-221</td>
<td>Laboratory II: Introduction to Chemical Analysis</td>
</tr>
</tbody>
</table>

Total: 20.5 units
Notes:

1. In addition to the graduation requirement of an overall QPA of 2.0 (not counting the first year), the Department of Chemical Engineering requires a cumulative QPA of 2.0 in all chemical engineering courses (all those numbered 06-xxx).

2. Minimum number of units required for graduation: 386.

3. Overloads are permitted only for students maintaining a QPA of 3.0 or better during the preceding semester.

4. Electives: To obtain a Bachelor of Science degree in Chemical Engineering, students must complete 06-100 and one other Introductory Engineering Elective. There are also five Unrestricted Electives. At most, 9 units of ROTC or Physical Education can be counted toward these electives. Students must discuss choice of electives with their faculty advisors.

5. Undergraduate Research: Independent research projects are available by arrangement with a faculty advisor. Many students conduct these research projects for elective credit by enrolling in 06-200, 06-300, or 06-400 (Sophomore, Junior, or Senior Research Projects) or 39-500 Honors Research Project for eligible Seniors.

6. Advanced undergraduates may also take Chemical Engineering graduate courses (600+ level).

Double Major in Engineering and Public Policy (EPP)

Students may pursue a double major in Chemical Engineering and EPP. This double major is very flexible, built around Electives, Social Analysis, Probability and Statistics courses, and projects. Specific course choices should be discussed with a faculty advisor and an EPP advisor.

Double Major in Biomedical Engineering (BME)

Students may pursue a double major in Chemical Engineering and BME. Specific course choices should be discussed with a faculty advisor and a BME advisor.

Minors with a B.S. in Chemical Engineering

Chemical Engineering students are eligible for any CIT Designated Minor. Those minors that are especially well suited to Chemical Engineering include Biomedical Engineering, Electronic Materials, Colloids, Polymers, Surfaces, Engineering Design, Environmental Engineering and Sustainability, Data Storage Systems Technology, and Automation and Control Engineering. The minor requirements may be fulfilled with electives. Other minors, such as the Supply Chain Management minor in association with the Tepper School of Business, are also available outside of CIT. These should be discussed with a faculty advisor.

Minor in Colloids, Polymers, and Surfaces (CPS)

Historically, the CPS coursework sequence has had a long-standing popularity among chemical engineering students. A detailed description of the minor can be found in the CIT Minors section of this catalog, or ask your Chemical Engineering faculty advisor, or the Director of CPS. Chemical Engineering students may use four of their electives to obtain the CPS minor. This is a sequence of closely related courses that explore the science and engineering of polymeric materials, particulates, micro-structured fluids, and interfacially engineered materials. Completion of the following five courses constitutes the CPS minor:

- 06-221 Thermodynamics 9
- 06-466 Experimental Polymer Science 9
- 06-609/09-509 Physical Chemistry of Macromolecules 9

Typically, 06-607 is taken in the spring of the Junior year, while 06-609 also known as 09-509, 06-426 and 06-466 are taken during the Senior year.

Practical Internships for Senior Chemical Engineering Students (PISCES)

Chemical Engineering students may apply in the fall of their Junior year for a salaried, one-year PISCES with a partner company. Admitted students begin their internships after completion of the Junior year. Following the internship, students return to complete their Senior year. There are several advantages of a one full-year internship, including the opportunity to gain a breadth of professional experience that is not generally possible in a shorter program, more opportunity to make important contributions to the partner company, and the opportunity to complete Senior year courses in their normal sequence with no need for curriculum rearrangements. Interested students should consult with their faculty advisors.

International Chemical Engineering Exchange Programs

Chemical Engineering students may apply during their Sophomore year to spend their Junior year at the University of Aachen in Germany or at Imperial College in London, Great Britain. A summer exchange program in Dortmund, Germany is also available. These exchange programs provide a great opportunity for students to obtain international experience while taking courses very similar to those offered at Carnegie Mellon. Students considering any of these programs should consult with their faculty advisors, and students considering the Aachen program in particular are advised to take at least one introductory German course before or during their Sophomore year.

Fifth Year Master of Chemical Engineering (MChem)

This degree offers qualified undergraduate students the opportunity to obtain a Masters degree in Chemical Engineering in less than one academic year.
year. The goal of the program is to produce skilled engineers who will have a deeper understanding of the fundamentals of chemical engineering as well as a broader set of professional skills and exposure to other technical disciplines. The MChE degree requires the completion of at least 96 units, with a cumulative QPA of 3.0. Junior and Senior undergraduates from the department may apply to the MChE program if they have an overall QPA of 3.0. Three letters of recommendation are also required. The deadline for application is February 1 for the Fall semester and October 15 for the Spring semester. All applications should be submitted to the Graduate Admissions Committee of Chemical Engineering.

Faculty

JOHN L. ANDERSON, Adjunct Professor of Chemical Engineering – Ph.D., University of Illinois; Carnegie Mellon, 1976–.

SHELLEY ANNA, Associate Professor of Chemical Engineering – Ph.D., Harvard University; Carnegie Mellon, 2003–.

LORENZ T. BIEGLER, University Professor and Bayer Professor of Chemical Engineering – Ph.D., University of Wisconsin; Carnegie Mellon, 1981–.

RAJ CHAKRABARTI, Associate Professor – Ph.D., Princeton University; Carnegie Mellon, 2012–.

KRIS N. DAHL, Associate Professor of Chemical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006–.

MICHAEL M. DOMACH, Professor of Chemical Engineering – Ph.D., Cornell University; Carnegie Mellon, 1983–.

NEIL M. DONAHUE, Professor of Chemical Engineering and Chemistry – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000–.

ANDREW J. GELLMAN, Lord Professor of Chemical Engineering, Head of Department – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992–.

IGNACIO E. GROSSMANN, University Dean Professor of Chemical Engineering – Ph.D., Imperial College, University of London; Carnegie Mellon, 1979–.

ANNETTE M. JACOBSON, Teaching Professor of Chemical Engineering and Director of Colloids, Polymers, and Surfaces Program – Ph.D., Carnegie Mellon; Carnegie Mellon, 1988–.

MYUNG S. JHON, Professor of Chemical Engineering – Ph.D., University of Chicago; Carnegie Mellon, 1980–.

ADITYA KHAIR, Assistant Professor of Chemical Engineering – Ph.D, California Institute of Technology; Carnegie Mellon, 2010–.

JOHN KITCHIN, Associate Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2006–.


JAMES B. MILLER, Research Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006–.

SPYROS N. PANDIS, Research Professor of Chemical Engineering and Engineering and Public Policy – Ph.D., California Institute of Technology; Carnegie Mellon, 1993–.

DENNIS C. PRIEVE, Gulf Professor Of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1974–.

NIKOLAOS V. SAHINIDIS, John E. Swearingen Professor of Chemical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

JAMES W. SCHNEIDER, Professor of Chemical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 1999–.

PAUL J. SIDES, Professor of Chemical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1981–.

ROBERT D. TILTON, Professor of Chemical Engineering – Ph.D., Stanford University; Carnegie Mellon, 1992–.

LYNN M. WALKER, Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1997–.

ARTHUR W. WESTERBERG, Emeritus, University Professor of Chemical Engineering – Ph.D., DIC, Imperial College, University of London; Carnegie Mellon, 1976–.

B. ERIK YDSTIE, Professor of Chemical Engineering – Ph.D., Imperial College, University of London; Carnegie Mellon, 1992–.
Department of Civil and Environmental Engineering

James H. Garrett Jr., Head
Office: Porter Hall 119-D
http://www.ce.cmu.edu/

The role of civil and environmental engineers, in the broadest sense, is to apply technology to meet society’s needs. Civil engineers plan, design, and manage facilities used daily by the public and industry, such as buildings, airports, water supply, and waste management systems. They work at the intersection of the built, natural, and information environments. Today’s civil and environmental engineers are also called upon by government and industry to provide leadership on complex technical and societal issues such as demands for infrastructure improvement in our cities, remediation of hazardous waste sites, provision of safe drinking water, and incorporation of environmental safeguards in new designs. Civil and Environmental Engineering requires broad technical training and strong communication skills because of the complexity of large projects and the interactions with engineers in other fields, lawyers, politicians, and the public. Carnegie Mellon’s curriculum is intended to provide this versatility for professional practice in civil and environmental engineering or as a foundation for other professional pursuits.

The Department of Civil and Environmental Engineering offers a wide spectrum of opportunities for direct entry into the engineering profession, for graduate education in engineering, or entry into various other professions. While maintaining its emphasis on the fundamental understanding of the behavior of constructed facilities through the application of the physical sciences and mathematics, the curriculum has continually evolved in directions that exploit advances in technology. The methods of engineering design are introduced in the freshman year and are emphasized throughout the curriculum in both traditional and open-ended project-oriented courses. The basic undergraduate degree program leads to a B.S. in Civil Engineering. Students with a specific interest in Environmental Engineering are advised to undertake the Minor in Environmental Engineering and Sustainability.

Central to the evolution of technology and its impact on engineering practice is the increased emphasis on computer-aided engineering. Several courses on computer methods are required in the curriculum, and virtually every course offered by the department requires the use of computers in applications of either analysis or design. Our curriculum emphasizes the development of scientific inquiry with the perspective of social, economic, and institutional developments. For graduates who wish to enter directly the engineering profession in such specialties as structural engineering, construction, or environmental engineering, this approach to teaching allows application of the most advanced technological developments.

Others who wish to pursue graduate study are prepared to engage in research on the highest level, either in traditional specialties or in emerging fields such as smarter infrastructure. For many years, some graduates also have found their undergraduate preparation highly suited for entry into graduate schools of business, law, and medicine.

A student may choose to concentrate in one of the specialty areas in Civil Engineering, to pursue a minor in one of the CIT designated minor programs, or to design a double major or double degree program. The specialty areas offered by the Civil and Environmental Engineering Department are described in this section. The CIT designated minor programs can be found under the Carnegie Institute of Technology section.

The double-major requirements with Biomedical Engineering and with Engineering Electives and associated Restricted Technical Electives within the curriculum have been designed, and are periodically evaluated and refined, to provide students instruction and experiences that lead to the development of these abilities and skills.

By the end of the B.S. program, students should have achieved the following student outcomes:

- A. an ability to apply knowledge of mathematics, science and engineering
- B. an ability to design and conduct experiments, as well as to analyze and interpret data
- C. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- D. an ability to function on multidisciplinary teams
- E. an ability to identify, formulate, and solve engineering problems
- F. an understanding of professional and ethical responsibility
- G. an ability to communicate effectively
- H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- I. a recognition of the need for, and an ability to engage in lifelong learning
- J. a knowledge of contemporary issues relevant to engineering practice
- K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The curriculum has been designed, and is periodically evaluated and refined, to provide students instruction and experiences that lead to the development of these abilities and skills. All students admitted to CIT are not required to declare a major until the end of the freshman year, and may have selected a variety of Introductory Engineering Electives and associated Restricted Technical Electives within the common foundation specified for freshmen in CIT. Regardless of this selection in the freshman year, a civil engineering major is expected to have completed, in addition to 12-100 Introduction to Civil and Environmental Engineering, the following Restricted Technical Electives by the end of the sophomore year:

- 09-105 Introduction to Modern Chemistry I 10
- 09-101 Introduction to Modern Chemistry II 3
- 15-110 Principles of Computing 10
- 21-120 Differential and Integral Calculus 10
- 21-122 Integration, Differential Equations and Approximation 10
- 33-106 Physics I for Engineering Students 12
- 33-107 Physics II for Engineering Students 12

Appearing below is the recommended four-year program of study for the BS in civil engineering. Advising and formulation of appropriate programs is available through the department for transfer students, students with advanced placement, or students wishing to study overseas.

Curriculum

Freshman Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-100 Introduction to Civil and Environmental Engineering</td>
<td>12</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-106 Physics I for Engineering Students</td>
<td>12</td>
</tr>
</tbody>
</table>
### Spring Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx Introduction to Engineering (other than CEE)</td>
<td>12</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>33-107 Physics II for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

### Sophomore Year

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-212 Statics</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
</tr>
<tr>
<td>09-101 Introduction to Experimental Chemistry</td>
</tr>
<tr>
<td>15-110 Principles of Computing</td>
</tr>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
</tbody>
</table>

### Spring Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-231 Solid Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>12-232 Solid Mechanics Lab</td>
<td>3</td>
</tr>
<tr>
<td>21-271 Introduction to Computer Application in Civil &amp; Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Dietrich College or CFA Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Elective 1</td>
<td>9</td>
</tr>
</tbody>
</table>

### Junior Year

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-301 Civil Environmental Engineering Projects</td>
</tr>
<tr>
<td>12-335 Soil Mechanics</td>
</tr>
<tr>
<td>12-336 Soil Mechanics Laboratory</td>
</tr>
<tr>
<td>12-355 Fluid Mechanics</td>
</tr>
<tr>
<td>12-356 Fluid Mechanics Lab</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS or CFA Elective</td>
</tr>
<tr>
<td>xx-xxx Elective 2</td>
</tr>
</tbody>
</table>

### Spring Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-351 Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-352 Environmental Engineering Lab</td>
<td>3</td>
</tr>
<tr>
<td>27-357 Introduction to Materials Selection</td>
<td>6</td>
</tr>
<tr>
<td>12-358 Materials Lab</td>
<td>3</td>
</tr>
<tr>
<td>36-220 Engineering Statistics and Quality Control</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Elective 3</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Elective 4</td>
<td>9</td>
</tr>
</tbody>
</table>

### Senior Year

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-401 Civil &amp; Environmental Engineering Design</td>
</tr>
<tr>
<td>12-411 Project Management for Construction</td>
</tr>
<tr>
<td>12-421 Engineering Economics</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS or CFA Elective</td>
</tr>
<tr>
<td>xx-xxx Elective 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx H&amp;SS or CFA Elective</td>
</tr>
<tr>
<td>xx-xxx Dietrich College or CFA Elective</td>
</tr>
<tr>
<td>xx-xxx Elective 6</td>
</tr>
<tr>
<td>xx-xxx Elective 7</td>
</tr>
<tr>
<td>xx-xxx Elective 8</td>
</tr>
</tbody>
</table>

### Minimum number of units required for degree: 379

### Notes on Electives

1. One elective must be in the basic sciences, from the following list:

- Modern Biology
- Geology

Substitutions may be made only with the approval of the Department Head.

2. One elective course is restricted to a 600-level Civil Engineering course except 12-648 and 12-690. The Civil Engineering elective is a co-requisite for 12-401.

### Specialty Areas in Civil Engineering

Students are encouraged to select a set of civil engineering and technical electives in the junior and senior years that enable them to concentrate in a specialty area if they so desire. Some available options for grouping electives into specialty areas, together with representative course selections, are indicated below.

#### Infrastructure Systems

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600 AutoCAD</td>
<td>3</td>
</tr>
<tr>
<td>12-605 Design and Construction</td>
<td>9</td>
</tr>
<tr>
<td>12-631 Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>12-636 Geotechnical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-657 Water Resources Engineering</td>
<td>9</td>
</tr>
<tr>
<td>15-211 Fundamental Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>18-100 Introduction to Electrical and Computer Engineering</td>
<td>12</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
</tbody>
</table>

#### Environmental Engineering

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-657 Water Resources Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-636 Geotechnical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-658 Hydraulic Structures</td>
<td>9</td>
</tr>
<tr>
<td>12-651 Air Quality Engineering</td>
<td>9</td>
</tr>
<tr>
<td>06-221 Thermodynamics</td>
<td>9</td>
</tr>
<tr>
<td>06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods</td>
<td>9</td>
</tr>
<tr>
<td>09-510 Introduction to Green Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>24-424 Energy and the Environment</td>
<td>9</td>
</tr>
<tr>
<td>48-596 LEED Buildings and Green Design</td>
<td>6</td>
</tr>
</tbody>
</table>

### Structures, Mechanics and Geotechnical Engineering

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600 AutoCAD</td>
<td>3</td>
</tr>
<tr>
<td>12-605 Design and Construction</td>
<td>9</td>
</tr>
<tr>
<td>12-631 Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>12-636 Geotechnical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>24-370 Engineering Design I: Methods and Skills</td>
<td>12</td>
</tr>
<tr>
<td>12-631 Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>12-636 Geotechnical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>24-262 Stress Analysis</td>
<td>12</td>
</tr>
<tr>
<td>24-356 Engineering Vibrations</td>
<td>11</td>
</tr>
</tbody>
</table>

### Double Majors and Minors

Civil engineering students may pursue double majors and minors in a variety of subjects, taking advantage of the free elective courses for other requirements. The college of engineering has added designated minors to promote flexibility and diversity among engineering students. Many CEE undergraduates pursue designated minors in such areas as Engineering Design or Environmental Engineering and Sustainability.

### Co-Operative Education Program

Students in civil engineering are encouraged to undertake professional internships during summer breaks. In addition, a formal cooperative internship program is available for either Jan-Aug or May-Dec in the junior year. Students undertaking these 8-month professional semesters of study. Program details are available from the Career Center or the Civil and Environmental Engineering office.

### Integrated B.S./M.S. Program

Interested undergraduates may plan a course of study that leads to both the BS in Civil Engineering and the MS in Civil and Environmental Engineering. This course of study will ordinarily require ten semesters of study, although advanced placement or other study may reduce this time. Students can apply appropriate units earned as undergraduates for their MS program as long as they are beyond the 379 units required for the BS in Civil Engineering degree. In the ninth semester of study, students must register in graduate status. Interested students should consult their academic
advisor or the CEE department office for information about admission to the MS program.

Faculty

AMIT ACHARYA, Professor of Civil and Environmental Engineering – Ph.D., University of Illinois at Urbana - Champaign; Carnegie Mellon, 2000–.

PETER ADAMS, Professor of Civil and Environmental Engineering and Engineering and Public Policy – PhD., California Institute of Technology; Carnegie Mellon, 2001–.

BURCU AKINCI, Professor of Civil and Environmental Engineering – Ph.D., Stanford University; Carnegie Mellon, 2000–.

MARIO BERGES, Assistant Professor of Civil and Environmental Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2010–.

JACOBO BIELAK, University Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology, P.E.; Carnegie Mellon, 1978–.

LAWRENCE G. CARTWRIGHT, Teaching Professor of Civil and Environmental Engineering and Director of the Civil Engineering Laboratories – M.S., Carnegie Mellon University, P.E.; Carnegie Mellon, 1977–.

JARED L. COHON, President and Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology, P.E.; Carnegie Mellon, 1997–.

KAUSHIK DAYAL, Assistant Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 2008–.

DAVID A. DZOMBAK, Walter J. Blenko, Sr. University Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology, P.E.; Carnegie Mellon, 1989–.

SUSAN FINGER, Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

JAMES H. GARRETT, JR., Thomas Lord Professor and Head, Civil and Environmental Engineering – Ph.D., Carnegie Mellon University, P.E.; Carnegie Mellon, 1990–.

KAUSHIK DAYAL, Assistant Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 2008–.

ATHANASIOS KARAMALIDIS, Assistant Research Professor of Civil and Environmental Engineering – Ph.D., Democritus University of Thrace; Carnegie Mellon, 2010–.

GREGORY LOWRY, Professor of Civil and Environmental Engineering – Ph.D., University of Illinois; Carnegie Mellon, 2002–.

H. SCOTT MATTHEWS, Professor of Civil and Environmental Engineering and Engineering and Public Policy – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001–.

CRAIG MALONEY, Associate Professor of Civil and Environmental Engineering – Ph.D., University of California, Santa Barbara; Carnegie Mellon, 2007–.

IRVING J. OPPENHEIM, Professor of Civil and Environmental Engineering and Architecture – Ph.D., Cambridge University, P.E.; Carnegie Mellon, 1972–.

MITCHELL J. SMALL, H. John Heinz Professor, Civil and Environmental Engineering and Engineering and Public Policy – Ph.D., University of Michigan; Carnegie Mellon, 1982–.

JAMES M. THOMPSON, Visiting Associate Teaching Professor – Ph.D., Lehigh University, P.E.; Carnegie Mellon, 2012–.

JEANNE VANBRIESEN, Professor of Civil and Environmental Engineering – Ph.D., Northwestern University, P.E.; Carnegie Mellon, 1999–.
Department of Electrical and Computer Engineering

Department of Electrical and Computer Engineering
T.E. (Ed) Schlesinger, Head
James Hoe, Associate Head
http://www.ece.cmu.edu/

The field of electrical and computer engineering encompasses a remarkably diverse and fertile set of technological areas, including analog and digital electronics, computer architecture, computer-aided design and manufacturing of VLSI/ULSI circuits, intelligent robotic systems, computer-based control systems, telecommunications and computer networking, wireless communication systems, signal and information processing and multimedia systems, solid state physics and devices, microelectromechanical systems (MEMS), electromagnetic and electromechanical systems, data storage systems, embedded systems, distributed computing, mobile computing, real-time software, digital signal processing, and optical data processing. The extraordinary advances in the field during the last fifty years have impacted nearly every aspect of human activity. These advances have resulted not only in advanced computer systems but also in consumer products such as “smart” cars, programmable dishwashers and other home appliances, cell phones and mobile computing systems, video games, home security systems, advanced medical systems for imaging, diagnosis, testing and monitoring. Systems and products such as these serve to enhance our quality of life and have also served as the basis for significant economic activity. In short, the field of electrical and computer engineering has become central to society as we know it.

The Department of Electrical and Computer Engineering at Carnegie Mellon is actively engaged in education and research at the forefront of these new technologies. Because of the diverse and broad nature of the field and the significant growth in knowledge in each of its sub areas, it is no longer possible for any single individual to know all aspects of electrical and computer engineering. Nevertheless, it is important that all electrical and computer engineers have a solid knowledge of the fundamentals with sufficient depth and breadth. Society is placing increasing demands on our graduates to try their skills in new contexts. It is also placing increasing value on engineers who can cross traditional boundaries between disciplines, and who can intelligently evaluate the broader consequences of their actions. Our curriculum is designed to produce world-class engineers who can meet these challenges.

Educational Outcomes and Objectives

The B.S. in Electrical and Computer Engineering is a broad and highly flexible degree program structured to provide students with the smallest set of constraints consistent with a rich and comprehensive view of the profession. It is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. Students are encouraged and stimulated to explore multiple areas of theory and application. The Faculty of Electrical and Computer Engineering have adopted the following outcomes from ABET and have established the following objectives for the B.S. in Electrical and Computer Engineering curriculum:

Educational Outcomes

1. An ability to apply knowledge of mathematics, science and engineering.
2. An ability to design and conduct experiments, as well as to analyze and interpret data.
3. An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. An ability to function in multi-disciplinary teams.
5. An ability to identify, formulate and solve engineering problems.
6. An understanding of professional and ethical responsibilities.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
9. A recognition of the need for, and an ability to engage in life-long learning.
10. A knowledge of contemporary issues.
11. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

ECE Education Objectives

The ECE program objectives are shown below. They represent our vision for what our students will be doing in their engineering careers five years after they have graduated. The principal behaviors we seek to foster in our students are expertise, innovation and leadership. Our graduates will be:

Experts

• They will solve problems by applying ECE fundamentals
• Their solutions will reflect depth of understanding in their sophistication.
• Their solutions will reflect breadth of understanding by drawing on multiple disciplines.

Innovators

• They will demonstrate creativity in their engineering practice.
• They will consider holistic systems-oriented approaches in their designs.
• They will think strategically in their planning and execution.

Leaders

• They will take initiative, and demonstrate resourcefulness.
• They will collaborate in multidisciplinary teams.
• They will be leaders in their organizations, their profession and in society.

Three dimensions of objectives for our graduates.

Curriculum Overview

Minimum number of units required for degree: 379 units.

In addition to the Carnegie Institute of Technology general education and freshman year requirements (143 units), the B.S. in Electrical and Computer Engineering requires 15-122 Principles of Imperative Computation (10 units), Physics II (12 units), two math or science electives (18 units), a Probability and Statistics course (9 units), 109 units of Electrical and Computer Engineering coursework, and 2 math co-requisites (21 units). The remaining units needed to reach the 379 required to graduate are Free Electives (57 units).

The Electrical and Computer Engineering coursework is divided into the categories of Core, Breadth, Depth, Coverage, and Capstone Design. The Core consists of five courses (18-100 Introduction to Electrical and Computer Engineering, 18-220 Electronic Devices and Analog Circuits, 18-240 Structure and Design of Digital Systems, 18-213 Introduction to Computer Systems, and 18-290 Signals and Systems). There are also two math co-requisites and Physics II that are required co-requisites for the core. These courses provide the fundamental knowledge-base upon which all other electrical and computer engineering courses are built. 18-100 is generally taken during the freshman year, while the remaining courses in the Core are taken starting in the sophomore year. The remaining four core courses are ideally completed by the end of the junior year (The department strongly recommends that students not take more than two core courses in the same semester). Although the core courses (and their co-requisites) may be taken in any order, students generally first take the course in their primary area of interest. This gives added flexibility to later course selection in related areas.

Students are also required to complete a seminar course during the fall semester of the sophomore year. This course, 18-200 Emerging Trends in Electrical and Computer Engineering, introduces students to the many areas within ECE and helps them decide which areas are of primary interest to them.

To satisfy the ECE Breadth Requirement, at least one Breadth course must be completed from the lists of Breadth courses on the Web for two of the following five principal areas in ECE (24 units):

• Applied Physics: Solid State Physics, Electromagnetic Fields and Waves, Magnetics, Optics, etc.;
### B.S. Curriculum

**Minimum number of units required for degree:** 379

For detailed information and regulations of the curriculum along with the degree requirements and the most recent version of the ECE curriculum primer and course descriptions, please refer to the ECE Home Page: [http://www.ece.cmu.edu/](http://www.ece.cmu.edu/)

**University Requirement**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>or 99-102 Computing @ Carnegie Mellon</td>
<td></td>
</tr>
</tbody>
</table>

**CIT Requirements** (see CIT section of the catalog for specifics [https://coursecatalog-new.web.cmu.edu/carnegieinstituteoftechnology/#programingeneraleducationformcitstudents]):

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIT General Education</td>
<td>12</td>
</tr>
<tr>
<td>Two semesters of calculus</td>
<td>20</td>
</tr>
<tr>
<td>33-106 Physics for Engineering Students</td>
<td>12</td>
</tr>
</tbody>
</table>

33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement.

**Specific ECE requirements:**

- One Introduction to Electrical and Computer Engineering course (generally taken during the freshman year)
- 18-100 Introduction to Electrical and Computer Engineering
- One ECE Seminar, taken during the fall of the sophomore year
- 18-200 Emerging Trends in Electrical and Computer Engineering
- Four ECE core courses, three with math co-requisites
- 18-220 Electronic Devices and Analog Circuits
- 33-107 Physics II for Engineering Students (co-requisite to 18-220)
- 18-290 Signals and Systems
- 18-202 Mathematical Foundations of Electrical Engineering (co-requisite to 18-220 and 18-290)
- 18-240 Structure of Computer Systems
- 21-127 Concepts of Mathematics (co-requisite to 18-240)
- 18-213 Introduction to Computer Systems
- Two Breadth Courses from 2 of the 5 Breadth areas within ECE
- One Coverage Course (any additional ECE course or Approved CS course as listed on the ECE web site)
- One Capstone Design Course (any 18-5xx course)

**Other ECE Requirements:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112 Fundamentals of Programming and Computer Science</td>
<td>12</td>
</tr>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>12</td>
</tr>
<tr>
<td>Two Math/Science electives</td>
<td>12</td>
</tr>
<tr>
<td>36-217 Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>or 36-225 Introduction to Probability Theory</td>
<td></td>
</tr>
<tr>
<td>Free Electives</td>
<td>57</td>
</tr>
</tbody>
</table>

The math/science requirement can be satisfied with any course from The Mellon College of Science or The Department of Statistics except for: 100-level courses in Mathematics or Statistics, and courses designed for non-science or engineering majors, such as (but not limited to) 09-103, 09-104, 21-257, 33-124, 36-201, 36-202, 36-207 or 36-208. Although shown in the Fall of the Junior and Senior years, these courses may be taken at any time. Mathematics courses of particular interest to students in ECE are:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9</td>
</tr>
</tbody>
</table>

**Free Electives** [57 units]

A Free Elective is defined as any graded course offered by any academic unit of the university (including research institutes such as the Robotics Institute [http://www.ri.cmu.edu] and the Software Engineering Institute [http://www.sei.cmu.edu]). A total of at least 60 units of Free Electives must be taken.

Up to 9 units of ROTC and Physical Education courses or other courses taken as Pass/Fail may also be used toward Free Electives.

Transfer of courses from other high-quality universities may be accepted through submission of the Transfer Credit Request form on the CIT web page ([http://www.cit.cmu.edu/current_students/services/transfer_credit.html](http://www.cit.cmu.edu/current_students/services/transfer_credit.html)).

The large number of units without categorical constraints provides the student, in consultation with their Faculty Advisor or Mentor, with the flexibility to design a rich educational program.

**Sample Curriculum**

The following table shows a possible roadmap through our broad and flexible curriculum:

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Sophomore Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-100 Introduction to Electrical and Computer Engineering</td>
<td>Spring Introductory Engineering Elective</td>
<td>18-200 Emerging Trends in Electrical Course 2</td>
<td>18-2xx ECE Core and Computer Engineering</td>
<td></td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>General Education Course</td>
<td>Free Elective</td>
<td>General Education Course</td>
<td></td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon or 99-102 Computing @ Carnegie Mellon</td>
<td>for Engineering Students</td>
<td>33-107 Physics II for Engineering Students</td>
<td>General Education Course</td>
<td></td>
</tr>
<tr>
<td>33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes on the Curriculum

**Policy on ECE Coverage Courses with Fewer than 12 Units**

The basic curriculum requirements for Breadth, Depth, Coverage and Capstone Design are stated in terms of courses rather than units. The nominal total of 60 units for these categories is determined by assuming that each course is 12 units. In the event that courses with fewer than 12 units are used to satisfy some or all of these requirements, additional courses from the ECE coverage lists must be taken until the total units in ECE courses beyond the core meets or exceeds 60 units. Any ECE coverage course is acceptable, and any excess units may be counted as free elective credit.
QPA Requirement and Overload Policy

An overload is defined as any schedule with more than 54 units in one semester. A student will only be permitted to overload by 12 units if he or she achieved a QPA of at least 3.5 out of 4.0 in the previous semester he or she is registering for, or if his or her overall QPA is at least a 3.5.

Pass/Fail policy

Up to 9 units of ROTC and Physical Education courses or other courses taken as Pass/Fail may also be used toward Free Electives. ECE core courses may not be taken as pass/fail. ECE project-based courses (including capstone design courses) may not be taken pass/fail. No ECE requirements may be fulfilled using a pass/fail course (except for 99-10X and 18-200).

Other Graduation Requirements

CIT has the following requirement for graduation. "Students must complete the requirements for their specified degrees with a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year (this is the CIT QPA on the Academic Audit). In addition, a student is expected to achieve a cumulative quality point average of 2.00 in a series of core departmental courses." In ECE, this means that the student must complete 18-100 Introduction to Electrical and Computer Engineering, ECE Core Breadth, Depth, Coverage, and Design courses with a minimum QPA of 2.0 to graduate.

When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses used for calculating the ECE QPA will be chosen so as to maximize the QPA. Similarly, when a course is retaken, the better grade will be used in the computation of the minimum QPA in the above courses.

Other Opportunities in ECE

ECE Cooperative Education Program

The ECE Co-Op is a unique 8-month contiguous extended internship experience in which ECE students with a minimum QPA of 3.0 may opt to participate in. Students typically engage in this option in the spring semester of their junior year, from January through August. A May through December option is also available. Students who engage in this program typically graduate in 4.5 academic years (but still eight semesters). Eligible students interested in participating should contact their advisor in the ECE Undergraduate and Graduate Programs Office. Students are required to submit a formal application consisting of a transcript, a resume, and a one-page statement of purpose including an academic plan. Students then work with the Career Center to find a Co-Op position. Once a Co-Op position is found, a Co-Op job description is required from the employer, to be approved by the ECE Undergraduate Office.

While on the Co-Op assignment, the students are participating in a recognized CIT educational program, retaining their full-time student status, akin to our students who study abroad in established exchange programs (such as NCTU or EPFL) for one or two semesters.

Upon returning to Carnegie Mellon, the students are required to submit for approval the following two documents to the ECE Undergraduate Office: a three to five page technical report of the Co-Op work, and a one page assessment and evaluation of the Co-Op experience. Students may obtain more detailed information through the department, the Career Center in the University Center, or online at http://www.ece.cmu.edu/undergrad/

Integrated M.S./B.S. Degrees Program

The Integrated Master's/Bachelor's program (otherwise known as the IMB program) is an exciting opportunity for students who excel academically to achieve not just a Bachelor's degree in ECE, but also a Master's degree through our Professional MS degree program-without needing to apply separately. This means no application fee, and no need to take the GRE (Graduate Record Exam). In order to be awarded the MS degree in the IMB program, the student must also earn their BS degree, either simultaneously with the MS degree or in a semester prior to the awarding of the MS degree. If a course is eligible for the MS degree but must be used to complete the BS degree, then the BS degree takes priority over the MS degree.

If a student is at least a 2nd semester junior, has completed at least 27 units and has at least an overall 3.00 QPA, he or she is guaranteed admission into the Professional MS degree in ECE through the IMB program. To be officially admitted, the student must complete the IMB Program form.

If a student does not meet the exact overall 3.00 QPA requirement, he or she is eligible to petition for his or her admission into the IMB program during his or her senior year. Students may obtain the petition forms through a meeting with their assigned academic advisor.

Professional MS Degree Requirements:

Please see the ECE web site for the requirements for the Professional MS degree (http://www.ece.cmu.edu/graduate/masters). For students in the ECE IMB program, all requirements for the Professional MS degree are in addition to the requirements for the BS in ECE. No requirements for the MS degree may be used in any way toward the BS degree, including minors, additional majors or dual degrees.

Residency requirements and financial impacts:

Once a student in the IMB program has completed all of the requirements for the BS degree, he or she may become a graduate (Masters) student. To do this, the student's undergraduate degree is certified, and that student officially graduates with the BS degree. Once a student's undergraduate degree has been certified, no more courses may then be applied toward the BS degree. This includes courses toward minors and additional majors, although students pursuing an undergraduate dual degree with another department may still continue to apply additional coursework toward that second degree.

If a student takes more than 8 semesters to complete both the BS and MS degrees, then he or she must be a graduate student for at least one semester before graduating.

To determine the most appropriate time for an undergraduate student to become a graduate student, he or she should consult with Enrollment Services to understand how becoming a graduate student will affect financial aid, and with his or her academic advisor to determine a course schedule. When a student is a graduate student through the IMB program, the department is able to provide some financial assistance through Teaching Assistantships. Please see the ECE web site for further information regarding this financial assistance.

Faculty

JIM BAIN, Professor of Electrical and Computer Engineering and Materials Science Engineering; Associate Director, Data Storage Systems Center – Ph.D., Stanford University; Carnegie Mellon, 1993–.

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Department of Engineering and Public Policy

M. Granger Morgan, Head
Deanna H. Matthews, Associate Department Head for Undergraduate Affairs
Office: Baker Hall 129

Mission Statement
The Department of Engineering and Public Policy (EPP) is a unique engineering department, whose overall objective is to enhance undergraduate engineering education with the perspectives and skills that enable the engineer to understand and work at the interface between technology and society. Society is largely responsible for setting the goals and framing the problems that engineers work on. However, technologies designed by engineers profoundly change the societies in which they operate. Technology has enabled a healthier, richer, and more productive society. At the same time, technology has contributed to the creation of many of the more serious problems our society faces.

Technology can help us build a happier, freer, and more fulfilling life, while maintaining risks and undesirable impacts at acceptable levels. But that does not happen automatically. It takes careful hard work by people who understand both technology and the society in which they live. In order to do their jobs responsibly and well in today's world, engineers must develop an understanding of the interface between technology and society and a command of the skills necessary to work at that interface. The undergraduate degree programs of the Department of Engineering and Public Policy (EPP) have been designed to allow engineering students at Carnegie Mellon University to add this important dimension to their traditional engineering education. EPP double major graduates, for the most part, will enter traditional engineering careers, but will carry with them a set of insights and skills that will help them to better deal with issues in technology and policy, and better exercise their ethical and social obligations as practicing professionals.

Educational Outcomes: Double Major Knowledge and Skills Development

Through required courses, carefully selected technical and non-technical electives, and project activities, double major students in Engineering and Public Policy develop the knowledge and skills needed to understand and address the broader social context of technology during the course of their future careers as practicing engineers. Specifically they develop:

- An understanding of ideas and analytical tools in economics, decision science, and other social sciences through several required courses and a group of "social analysis electives."
- A knowledge of probability and statistics beyond that acquired by many engineering single majors.
- An understanding of how technical and social issues interact and affect each other through a set of required "EPP technical electives" (these courses are also available to other CIT students who wish to broaden their technical education).
- An appreciation of, and ability to deal with, ethical issues posed by technology and technical systems through case studies and discussion in the EPP Sophomore Seminar. Additionally, students may choose EPP technical and social analysis electives that cover ethics in disciplinary, philosophical, societal, and technical contexts.
- Hands on experience in integrating their technical and social analytical skills by addressing current, open-ended technology and public policy problems in two group project courses. These courses also require students to work in interdisciplinary groups, and they enhance communications skills through group processes and formal presentations.
- An understanding of how decision-makers in governments and other institutions can ethically use technical and scientific information when devising or evaluating public policy.

Double Major Objectives: Advantages in Career Paths

By design, most graduates from Engineering and Public Policy pursue traditional technical career paths. However, the double major provides students with additional insights and abilities such as:

- Displaying an understanding that engineering is not practiced in isolation. Technical products and systems are shaped, conditioned, and evaluated by society while at the same time technology shapes the social world.
- Recognizing situations and knowing how to seek advanced assistance where one’s work may have effects in areas beyond the traditional expertise of engineers: These areas include health and safety; environmental and economic regulation; and impacts of technological innovation.
- Displaying an appreciation of the difference between the effects and attributes of engineering a single device or small system, versus engineering for mass consumption or for large technological systems.
- Using, or seeking help in using, tools and methods to approach complex decision problems that engineers often must face, including issues beyond the design of products and processes.
- Considering career paths more diverse than those traditionally associated with engineering or other technical careers.
- Demonstrating an ability to integrate conventional technical analysis with behavioral and other social issues, where the engineer is a participant in teams composed of many disciplines.

The double major graduates in Engineering and Public Policy use the additional dimension in their background to improve the quality, sensitivity, and social work, awareness of their work, and the work of their colleagues. Many who begin in conventional engineering careers later migrate into positions with responsibilities which make special use of their EPP education. A number of graduates elect careers with local, state, or national government or with policy research and consulting firms. Some choose to continue their formal education, doing graduate work in an engineering discipline, in the social sciences, law, or in an interdisciplinary program.

Overview of the EPP Double Major

The department offers double major B.S. degree programs with each of the five traditional engineering departments in the engineering college, as well as with the School of Computer Science. The engineering double major programs lead to fully accredited engineering degrees that prepare students for traditional engineering careers. EPP double major engineers are not educated to be a different kind of engineer. Rather their education is intended to enable them to be better, more socially responsible engineers in the traditional engineering fields. The department also offers a minor in Technology and Policy for non-engineering majors.

All of the undergraduate double major programs in EPP combine the strong foundation in mathematics and physical sciences, and the development of engineering skills in the specific engineering field, with a rigorous preparation in the analysis of social and political problems. The curricula include subject matter which is not part of traditional engineering or social science curricula, but which contains elements of each. This is accomplished by Engineering and Public Policy technical elective courses, social analysis courses, and through participation by each student in at least two interdisciplinary problem-solving projects. Problem areas for these projects are chosen from local, state, and national situations and include such topics as industrial automation and robotics, environmental control, telecommunication and computer technologies, product safety, and energy systems. Engineering and Public Policy students take courses in engineering and science offered by the Carnegie Institute of Technology and the Mellon College of Science. They also take social science, humanities, and industrial administration courses offered in the College of Humanities, Social Sciences, and the Tepper School’s undergraduate business program. There is also significant interaction between EPP students and the Heinz College, and the Department of Social and Decision Sciences.

All undergraduates interested in the program complete their freshman year before declaring their major. Students planning to be double majors with chemical, mechanical, or materials sciences and engineering are especially advised to check the double major curriculum before selecting their freshman elective courses so as to avoid possible overloads later in the program.

Some of the designated minors such as the Environmental Engineering minor are also compatible with the EPP double major without overload, if the program of study is carefully planned beginning in the freshman year. Additional non-CIT minors such as Business Administration or an A&S discipline may not be possible without overloads. If you are interested in exploring these options, please contact the EPP undergraduate advisors early.

Credit-unit overloads of between one and six units are also involved. To ease these overloads, some students occasionally elect a minimum of summer work. Course and credit-unit requirements for the single major and double major degrees are listed below.
Faculty Advisors
Faculty in several departments serve as advisors and information resources to students selecting the EPP undergraduate programs. Given the interdisciplinary perspective of EPP, students may find that a faculty member outside their traditional major can provide support and guidance with EPP-related courses and career paths. The EPP Associate Department Head for Undergraduate Affairs is Deanna Matthews. Dr. Matthews can provide general academic advice and guidance for all EPP double majors. Other faculty affiliated with the undergraduate programs in EPP are:

- Civil Engineering: Peter Adams, Scott Matthews, Mitch Small
- Computer Science: Lorrie Cranor
- Electrical and Computer Engineering: Marija Ilic, Marvin Sirbu
- Engineering and Public Policy: Ines Azevedo, Liz Casman, Erica Fuchs, Paulina Jaramillo, Deanna Matthews
- Mechanical Engineering: Jeremy Michalek, Edward Rubin
- Material Science and Engineering: Jay Whitacre
- Social and Decision Sciences: Paul Fischbeck, Baruch Fischhoff

Double Major Curricula

Note: Students in the Class of 2015 and earlier should refer to the Course Catalog for the year they enrolled for EPP degree requirements.

Bachelor of Science in an Engineering Field/Computer Science and Engineering and Public Policy

The EPP double major curriculum consists of two sets of core courses: one set for the disciplinary major (ChE, CIV, CS, ECE, MEG, MSE) and the second set for the interdisciplinary EPP major. The student is referred to the relevant sections of this catalog for the core courses in the disciplinary major. The student simultaneously satisfies all requirements for the undergraduate degree in a traditional engineering department or computer science, and all requirements for the undergraduate degree in Engineering and Public Policy. With early planning, some of the designated minors are also possible without overload.

Specific degree requirements for the double major program vary with each department. With the exception of a three-unit seminar course, the double major program requires the same number of courses for completion as the corresponding single major departmental degree programs. However, as the curriculum below illustrates, there are substantial differences between elective course requirements for the double major and single major students.

<table>
<thead>
<tr>
<th>Field</th>
<th>Single Major Units</th>
<th>Double Major with EPP Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>386</td>
<td>392</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>379</td>
<td>388</td>
</tr>
<tr>
<td>Computer Science</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>Electrical and Computer Engineering</td>
<td>379</td>
<td>385</td>
</tr>
<tr>
<td>Materials Science and Engineering</td>
<td>379</td>
<td>385</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>382</td>
<td>389</td>
</tr>
</tbody>
</table>

The EPP curriculum consists of the following courses:

19-201 EPP Sophomore Seminar 3
19-45x EPP Projects (2 semesters) 24
73-100 Principles of Economics 9
88-xxx Decision Analysis Course 9
36-xxx Probability and Statistics (2 courses) 18
Four EPP Technical Electives 36
Four EPP Social Analysis Electives 36

The above courses for the EPP curriculum in general replace technical and general education requirements, seminars, and free electives of the single major.

EPP Core Course Requirements

The EPP Core courses include the EPP Sophomore Seminar and EPP Projects courses. EPP Sophomore Seminar is offered in the fall and may substitute for a disciplinary seminar course for the primary majors with a seminar requirement. This course prepares students for the double major experience through discussion and assessment of technology-policy interactions. EPP Projects are taken twice by all students, either in the Spring of Junior year and once in Senior year or during both semesters Senior year. EPP Projects are technology/policy projects which deal with research and development of recommendations for solving actual and critical problems currently affecting society. The students, faculty, and graduate student managers for the project are drawn from EPP, Heinz, and Heinz College, and hence bring different areas of expertise to the structuring and solution of the problem.

The topics for EPP Projects are drawn from diverse areas such as environmental systems and resources, public transportation, urban engineering problems, energy and fuel utilization, the interaction of law and technology, strategic materials and vulnerability of supply, technical issues in national security, and problems in automation, robotics and communication technology.

Examples of past project course topics and final reports are available: http://www.epp.cmu.edu/undergraduate/project_courses.html

Note: Students completing the EPP major are not required to take Introduction to Engineering and Public Policy (19-101) as the second introductory engineering course, although taking it as the second introductory engineering elective course serves as an opportunity to learn about the kind of questions and issues studied in EPP.

Technical Course Requirements

Probability and Statistics Sequence

In today’s world, knowledge of probability and statistics is critical in understanding how technological systems operate. The EPP double major requires that students take a 2 course sequence in probability and statistics. Most of the traditional majors require a statistics course, typically 36-220 Engineering Statistics and Quality Control, which will count towards meeting one course of the two course requirement. A list of qualifying statistics courses to meet the second course requirement is assembled each semester. The statistics courses fill disciplinary technical elective and free elective course slots in the traditional major curriculum as follows:

- ChE/EPP majors take in place of a disciplinary technical elective and the second course in place of a free elective.
- CivE/EPP majors have 36-220 in their single major curriculum, and take the second course as a free elective.
- CS/EPP majors should take 36-217 as part of their single major curriculum, and take the second course as a free elective.
- ECE/EPP majors must take 36-217 or 36-225 in their single major curriculum, and take the second course as a free elective. Note that 36-217 is the preferred option for students planning to take the communications course. Either 36-220 Engineering Statistics and Quality Control or 36-226 Introduction to Statistical Inference are recommended for the second statistics course.
- ME/EPP majors take 36-220 as part of their single major curriculum, and take the second course in place of a technical elective.
- MSE/EPP majors take 36-220 as part of their single major curriculum and the second course in place of a technical elective.

Students should complete the initial statistics course as early as possible, preferably by the end of Sophomore year.

EPP Technology-Policy Electives

EPP Technology-Policy Electives include courses in CIT, MCS, or SCS that generally belong to two categories: courses which synthesize engineering analysis and social analysis perspectives and apply them to problems with substantial societal technological components; and courses which teach methods or background vital to classes of important problems at the technology-society interface. Specific areas of interest for these courses are

1. energy, resources, and the environment,
2. risk assessment,
3. forensic engineering,
4. urban engineering,
5. information and communication technology,
6. product engineering and design,
7. robotics.

Courses in other topic areas may also be included as determined from year to year. Students should work with their advisors to define areas of concentration or a selection of breadth courses for the Technology-Policy Electives. Students use free elective units to complete these electives.

Each student elects four of these courses. A list of qualifying Technology-Policy Electives is assembled each semester. The following categories of courses count as Technology-Policy Electives:

19-xxx EPP departmental courses are considered Technology-Policy Electives. Exceptions to this rule will be identified when the courses are offered.

- Courses in engineering, mathematics, or science that have direct policy analysis applications are considered Technology-Policy Electives. Examples include mathematics courses related to optimization, estimation, and related topics.
- Courses on substantive technical issues of relevance to policy analysis are considered Technology-Policy Electives. While most technical domain knowledge has some application to policy, qualifying courses are those with information that is essential to deal with policy domains in which EPP students and faculty are actively engaged. Examples include courses in environmental engineering, electric power and energy systems, biological processes relevant to health and safety risks, climate change, and processes of engineering design.
Some disciplinary major required courses are as follows. Because several traditional majors cannot accommodate four EPP Technology-Policy Electives without overload, EPP counts selected courses in those departments as Technology-Policy Electives even though the courses may not exactly meet the above selection criteria. In some cases, a course is modified slightly for content deemed relevant to EPP, and EPP students register under a separate number for the course.

- CHE/EPP students count three CHE core courses, 06-421 Chemical Process Systems Design, 06-462 Optimization Modeling and Algorithms, and 06-463 Chemical Product Design as two EPP Technology-Policy Electives and take only two more EPP Technology-Policy Electives.
- CEE/EPP students count two core mini courses, 12-421 Engineering Economics and 27-357 Introduction to Materials Selection, as one EPP Technology-Policy Elective, and take only three more EPP Technology-Policy Electives.
- ME/EPP students count 24-441 Engineering Design II: Conceptualization and Realization as an EPP Technology-Policy Elective, and take only three more EPP Technology-Policy Electives.
- MSE/EPP students count 27-401 MSE Capstone Course I as one EPP Technology-Policy Elective and take only three more EPP Technology-Policy Electives.

Social Analysis Course Requirements

Decision Analysis and Economics Requirements

For analysis of technical and policy problems in the department, it is important to understand how decisions are made and how economic conditions affect alternatives. Students are required to complete the following economics course:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
</tbody>
</table>

Students should complete 73-100 as early as possible, preferably during their freshman year.

Students are also required to complete one decision analysis course.

Either 88-223 Decision Analysis and Decision Support Systems or 88-302 Behavioral Decision Making are acceptable. Other decision analysis courses may be substituted with permission. Both 88-223 and 88-302 have a statistics course prerequisite.

Social Analysis Electives

In addition to traditional engineering skills, EPP double majors are expected to acquire social science skills that prepare them to address the complicated problems which confront engineers in both the public and private sector. Courses that fulfill the Social Analysis Elective category fall into a number of topic areas, such as (1) economics, (2) interpersonal processes, (3) organizations, (4) ethics, (5) political analysis, (6) urban analysis, (7) technology and society, (8) international peace and security, (9) policy analysis, and (10) the role of computers in institutions. Courses in other topic areas may also be included as determined from year to year. Students are permitted to choose their electives concentrated in one topic area, or they can select a breadth of courses in different areas. A list of qualifying Social Analysis Electives is assembled each semester.

The Social Analysis Electives include courses in Architecture, Business Administration, Economics, English, History, Modern Languages, Philosophy, Psychology, and Social and Decision Sciences. Occasionally, these departments may offer a course which we deem unsuitable as a Social Analysis Elective. Some courses from CIT, MCS, and SCS may be appropriate for Social Analysis Electives depending on the content. Students should check the electives course list each semester for acceptable courses.

Students should work with their advisors to select appropriate Social Analysis Elective courses. Note that students pursuing an EPP double major complete the Social Analysis course requirements as part of the CIT General Education program. Courses should be selected to fulfill requirements in the four general education categories: Innovation and Internationalization; People, Places and Cultures; Social Analysis and Decision Making; and Writing and Expression; or the two general education free elective slots.

Notes on EPP double major requirements

Freshman Electives: In order to avoid overloads later in the curriculum, students wishing to pursue the EPP double major should complete the technical electives for the first two years as required by the student’s other traditional technical department. These requirements, including math, physics, and other science courses, are listed in the Undergraduate Catalog for the various departments.

For CIT students, the introductory engineering course in the major and a second introductory course must be completed. Introduction to Engineering and Public Policy is recommended but not required. Other courses that should be completed during the First Year include 76-101 Interpretation and Argument and 73-100 Principles of Economics. Students should complete their first statistics course by the end of Sophomore year.

A MSE/EPP double major may choose the Industrial Internship Option (IIO) which is a MSE program in cooperative education, just as in the MSE single major IIO option, the MSE/EPP IIO option provides the students with an opportunity to supplement the academic program with relevant work experience in metallurgy and materials science as well as in the public policy area.

Side-by-side comparison charts (http://www.epp.cmu.edu/undergraduate/curriculumcharts.pdf) of the curricula for the traditional majors alone versus the traditional majors with the EPP double major can assist students in determining the course requirements and scheduling needed to complete the degree requirements.

Students who feel that they may be interested in an EPP double major program are advised to check with the appropriate faculty advisor or with the Associate Department Head for Undergraduate Affairs in the EPP Department about the optimal selection of courses. By planning the four-year curriculum early, the student can be sure to get the maximum flexibility, and the maximum advantage from any advanced placement credits he or she may have.

Fifth Year M.S. program in Engineering and Public Policy

Students affiliated with the department may apply for the fifth year masters program that will lead to the additional degree of Master of Science in Engineering and Public Policy. This three-year study will ordinarily require two additional semesters of study beyond that required for the undergraduate degree in the primary major and EPP double major. Some coursework towards the MS may be able to be completed during the student’s senior year, however no courses taken may count for both a BS in CIT and the MS in EPP. The primary concern for scheduling and completing this integrated program is completing all the core courses in the EPP graduate program, as some of these courses are taught every other academic year only. Students interested in the program must have a minimum 3.0 GPA and should contact their advisor for details on the application process and course requirements.

Minor in Technology and Policy

The department also offers a minor in Technology and Policy to non-CIT majors. This minor allows non-technical students to sample the EPP requirements and develop exposure and awareness to issues at the interface of science, technology and society. Details of this program are provided in the discussion of CIT minors; see Technology and Policy Minor Description (p. 98).

Bachelor of Science in Engineering and Public Policy and Master of Science in Public Policy and Management

Highly motivated and talented students can earn the EPP double major bachelor’s degree, and a master’s degree in the H. John Heinz College of Public Policy and Management in a five-year course of study. Students interested in the combined degree program should enroll in a standard double major program in an engineering specialty and EPP. During the third year of study, the student applies to the Heinz College for admission to the master’s program; an academic record of B average or better is normally a prerequisite for admittance.

The five-year course of study is possible because of specific course load overlaps between the EPP and Heinz College programs: (1) some social analysis requirements in EPP, usually four semester courses, can be satisfied with Heinz College common core courses in economics and social science; (2) at least one project course is common and applicable to both curricula; (3) at least one additional EPP technical elective, engineering option or project course, will be accepted for Heinz College credit following the usual request to the master’s committee.

Students desiring this option should seek faculty advice and counsel in their freshman or sophomore year so that a curriculum satisfying all the degree requirements can be ensured. Contact the Associate Department Head for Undergraduate Affairs in EPP for more information. For general information on Heinz 3-1-1 programs please contact the Heinz College or refer to their website.

EPP Undergraduate/Graduate Level Courses

Many courses taught by the department (19-XXX courses) are offered to undergraduate and graduate students. These “dual level” courses are offered in two formats:

- Some courses are taught under both an undergraduate and graduate number. An example is 19-402 Telecommunications, Technology Policy & Management. In these types of courses, students who sign up under the 700-level (graduate) course number may be expected to perform
the same coursework at a higher level, and/or complete additional coursework, compared to 19-4XX students. Undergraduates who choose to take the course under the graduate number will be also be expected to work at the higher expectation/coursework level.

- Other courses are taught under a 600 level number. An example is 19-688 Innovation for Energy and the Environment. These courses may be taken by undergraduates as a senior level course, or by graduate students as a graduate level course. As with dual number courses, graduate level students or undergraduates taking the course for graduate credit, may be required to perform coursework at a higher level and/or complete additional coursework. Undergraduates who are taking a 600 level course for graduate credit should identify this fact to both the course instructor and to their EPP department advisor.

Students who have questions about the requirements of a specific EPP 400/700, or 600 level course, should contact the course instructor.

Other departments may have different policies regarding courses offered under both an undergraduate and graduate number, and courses offered under numbers other than the 100, 200, 300, 400, or 700 levels. Students who wish to take these courses should check with those departments for their specific policies.

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Department of Mechanical Engineering

Shi-Chune Yao, Interim Department Head
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http://www.cmu.edu/me

General Overview

Mechanical engineers design, analyze, and manufacture new products and technologies. They address society’s needs by combining mechanical engineering fundamentals with innovative ideas. We structure our curriculum by emphasizing engineering theory, hands-on experience and technical skills. By doing so, our students learn how to solve practical problems and analyze situations by converting concepts into reliable and cost-effective devices and processes.

Mechanical engineers work in a variety of sectors: small start-up companies, multi-national corporations, government agencies, national laboratories, consulting firms, and universities. Specializing in research, design, manufacturing, or management, they design and implement devices that affect our daily lives. For example:

- Jet Engines
- Automobiles
- Aircraft and Spacecraft
- Acceleration and Pressure Sensors
- Heating, Ventilating, and Air Conditioning Systems
- Power Generations Systems
- Biomedical and Biomechanical Devices (such as artificial hip implants)
- Mechanical and Electronic Systems (such as robots)

Through our curriculum, students receive a solid scientific foundation from the start. During their first year, students take courses in mathematics, physics, computer programming, and chemistry. In addition, students also take two introductory engineering courses which expose them to the different engineering departments. Our mechanical engineering introductory course is project-oriented; students learn about the various disciplines of mechanical engineering through lectures, laboratories, and hands-on projects.

In their sophomore and junior years, students take core engineering courses to develop strong engineering fundamentals. These course topics include:

- Solid and Fluid Mechanics
- Thermodynamics
- Heat Transfer
- Dynamics
- Systems and Controls
- Design Methods and Skills
- Experimentation and Numerical Methods

During their senior year, students complete a capstone course in engineering design. In this course, students work on teams to develop prototype hardware for new products. These projects expose students to the design process, from concept to product, and emphasize effective communication and presentations skills. Past design projects include:

- low-squeal disk brakes
- high efficiency engines
- neck gear to minimize spinal injury in sports
- stabilizer support arm for movie cameras

Additionally, students can utilize our flexible elective structure to pursue individual interests. We recognize the broad role mechanical engineers play in society—as leaders in business, government, and law. Therefore, we offer elective options that enable students to:

- begin taking elective courses during their junior year
- specialize in a particular area of mechanical engineering
- emphasize a technical area within another engineering or science department
- pursue interests in another Carnegie Mellon department (such as foreign language, design, music, or business) to earn a double major or minor

We offer advanced courses that students can choose as electives, depending on their interests. Electives include:

- energy conversion
- controls
- vibrations
- dynamics
- manufacturing
- robotics
- internal combustion engines
- mechatronics
- fluid and solid mechanics
- aerodynamics
- engineering design

As mentioned, students can also take technical and non-technical electives from other Carnegie Mellon departments. Students can use these courses to pursue a double major or minor, or develop an individual concentration with a faculty advisor.

Students can also tailor their undergraduate experiences through study abroad, research, or the Accelerated Graduate Program. In today’s global society, a study abroad experience is crucial and should serve as an integral part of an undergraduate engineering education, including a possible college International Engineering minor. An academic experience abroad is encouraged and assistance provided for course choices, but students may also participate in research, complete an internship, or partake in an international service-learning engineering (ISLE) project abroad. Exceptional students are eligible to participate in departmental or college senior honors research under faculty supervision, which students find enriching. In the Accelerated Graduate program, students take graduate courses during their senior year, accumulating credit toward their Master’s degrees. Students can then complete all the requirements for the M.S. degree (course-work option) in the summer and fall following their B.S. degree.

Students use the latest computer-based design and analysis methods for their courses and project work, including industry-standard design tools aided by computers. We provide an undergraduate computer lab where students can complete design work, structural analyses, thermal/flow finite element analyses, and dynamic system simulations. Using computer tools, students can visualize a product’s performance before they fabricate it.

We also provide students with a variety of resources including MIG welding, rapid prototyping, and a fully equipped student shop (includes lathes, drill presses, milling machines, band saws, and other hand and power tools). Our Thermal Fluids and Mechanical Systems laboratories contain state-of-the-art experimentation hardware and software.

Our faculty performs research sponsored by industry and government agencies. Faculty often use their research results as specific examples, case studies, and projects in undergraduate courses, allowing students to see firsthand the recent advances in mechanical engineering.

We also sponsor frequent seminars and invite nationally and internationally reputed speakers to give lectures. We encourage all students to attend these seminars to learn about broad perspectives on mechanical engineering.

You can find additional information about the Mechanical Engineering program on our website, http://www.cmu.edu/me/. Additionally, we describe our resources and policies in more detail in our Undergraduate Student Handbook, available online.

Educational Objectives

According to ABET (http://www.abet.org/) which evaluates applied science, computing, engineering and technology programs for accreditation, “program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation.” In view of this definition, the Mechanical Engineering program at Carnegie Mellon has the two following program educational objectives:

- Graduates distinguish themselves as innovative problem solvers and leaders in multidisciplinary settings, making use of a high quality and rigorous technical education that is enriched by a flexible curriculum and interdisciplinary research opportunities.
- Graduates excel in diverse career paths in either the engineering profession or an alternative field, or succeed in graduate studies.

The undergraduate curriculum in the Department of Mechanical Engineering offers students significant opportunities to pursue directions of personal interest, including minors, double majors, participation in research projects, and study abroad. Design and teamwork experiences occur at regular intervals in the curriculum, and graduates have significant hands-on
experience through laboratories and projects. The faculty of the Department has endorsed the following set of skills, or outcomes that graduates of the program are expected to have:

A. an ability to apply knowledge of mathematics, science, and engineering
B. an ability to design and conduct experiments, as well as to analyze and interpret data
C. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
D. an ability to function on multidisciplinary teams
E. an ability to identify, formulate, and solve engineering problems
F. an understanding of professional and ethical responsibility
G. an ability to communicate effectively
H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
I. a recognition of the need for, and an ability to engage in lifelong learning
J. a knowledge of contemporary issues
K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice


Curriculum

The following template outlines the four-year B.S. program through the standard and recommended course sequence. To ensure that prerequisites are completed and to prevent scheduling conflicts, students should discuss any changes to this sequence with the department academic advisor.

Freshman Year

Fall | Units
--- | ---
21-120 | Differential and Integral Calculus 10
24-101 | Fundamentals of Mechanical Engineering 12
33-106 | Physics I for Engineering Students 12
99-101 | Computing @ Carnegie Mellon 3
76-101 | Interpretation and Argument 9

Total Units: 46

Spring | Units
--- | ---
21-122 | Integration, Differential Equations and Approximation 10
xx-xxx | Second Introductory Engineering Course 12
xx-xxx | Restricted Technical Elective 10-13 10
xx-xxx | General Education Course 9

Total Units: 41

Sophomore Year

Fall | Units
--- | ---
21-259 | Calculus in Three Dimensions 9
24-223 | Thermodynamics I 10
24-261 | Statics 10
xx-xxx | Restricted Technical Elective 10-13 13
xx-xxx | General Education Course 9
24-200 | Machine Shop Practice 1

*Preferred sophomore year; required by senior year *

Total Units: 52

Spring | Units
--- | ---
21-260 | Differential Equations 9
24-231 | Fluid Mechanics 10
24-262 | Stress Analysis 12
xx-xxx | Restricted Technical Elective 10-13 12
xx-xxx | General Education Course 9
24-202 | Introduction to Computer Aided Design 1

*Preferred sophomore year; required by spring of junior year *

Total Units: 53

Junior Year

Fall | Units
--- | ---
24-302 | Mechanical Engineering Seminar I- taken either fall or spring 2
24-311 | Numerical Methods 12
24-322 | Heat Transfer 10
24-351 | Dynamics 10

Senior Year

Fall | Units
--- | ---
24-441 | Engineering Design II: Conceptualization and Realization- required either fall or spring; alternate with xx-xxx 9 unit elective 12
24-452 | Mechanical Systems Experimentation 9
xx-xxx | Elective 9
xx-xxx | Elective 9
xx-xxx | General Education Course 9

Total Units: 48

Spring | Units
--- | ---
24-441 | Engineering Design II: Conceptualization and Realization OR xx-xxx Elective 12
24-xxx | Mechanical Engineering Technical Elective 9-12
xx-xxx | Elective 9
xx-xxx | Elective 9
xx-xxx | General Education Course 9

Total Units: 48-51

Notes on the Curriculum

1. Students need a minimum of 382 units to complete the B.S. degree.
2. During the first year, students complete 24-101 Fundamentals of Mechanical Engineering and another introductory engineering course. If students did not take 24-101 during their first year, they should take 24-101 during their fall semester of their sophomore year in place of the General Education Course. They can then replace that General Education Course in their junior or senior years.
3. Students must pass the following three courses before they begin the core Mechanical Engineering courses in the fall of their sophomore year:
   - 21-120 Differential and Integral Calculus (units)
   - 21-122 Integration, Differential Equations and Approximation (units)
   - 33-106 Physics I for Engineering Students (units)*
   *33-106 / 33-107 is the recommended sequence for engineering students, although 33-111 / 33-112 or 33-131 / 33-132 would also meet the CIT Physics requirement.
4. Mechanical engineering undergraduates must satisfy a Science Laboratory requirement to graduate. Normally the Science Laboratory requirement is satisfied by passing 09-101 Introduction to Experimental Chemistry (3 units). Students can also satisfy the Science Laboratory requirement by passing one of the following courses:
   - 03-124 Modern Biology Laboratory 9
   - 33-100 Basic Experimental Physics 6
   - 33-104 Experimental Physics 9
   - 42-203 Biomedical Engineering Laboratory 9
   These courses may have prerequisites and tight enrollment limits that students should consider in their planning.
5. Students are required to complete 36-220 Engineering Statistics and Quality Control, which may be scheduled in any semester. The sequence of calculus courses (21-120, 21-122, 21-259) and 21-260 Differential Equations should be scheduled as indicated, due to Mechanical Engineering Core class prerequisites.
6. The communications requirement can be satisfied by completing at least one of the following options:
   - 24-302 Mechanical Engineering Seminar I- either fall or spring 2
   - 70-340 Business Communications 9
   - 76-270 Writing for the Professions 9
7. Students must enroll in 24-452 Mechanical Systems Experimentation in the fall of their senior year.
8. 24-441 Engineering Design II: Conceptualization and Realization may be taken in either fall or spring of senior year.

Restricted Technical Electives

Students should have the following courses completed by the end of their sophomore year. These courses are listed as "Restricted Technical Electives"
in the example course sequence. Students do have some flexibility in how they sequence these courses during their freshman and sophomore years:

- 33-107 Physics II for Engineering Students 12
- 09-101 Introduction to Experimental Chemistry 3
- 09-105 Introduction to Modern Chemistry I 10
- 15-110 Principles of Computing 10

Mechanical Engineering Technical Electives

We require students to take at least one elective labeled as “Mechanical Engineering Technical Elective” in the example course sequence. Students must take at least one non-core 24-xxx course (9-unit minimum) to fulfill the technical elective requirement. Options include:

- **Design and Manufacturing**
  - 24-201 Engineering Graphics 9
  - 24-341/342/343 Manufacturing Sciences 9
  - 24-365 Special Topics: Applied Finite Element Analysis 9
  - 24-484/485/486 Decision Tools for Engineering Design and Entrepreneurship 12
  - 24-674 Special Topics in Design of Biomimetic Systems for Humans 12
  - 24-681 Computer-Aided Design 12
  - 24-682/683/684 Computer-Aided Engineering 12
  - 24-689/690 Design for Manufacture and the Environment 12
  - 24-687/688 Special Topics Grand Challenges: Technology Identification and Product Design
  - 24-488/489 Special Topics: Introduction to CAD and CAE Tools 12

- **Mechanical Systems**
  - 24-355/356/357 Kinematics and Dynamics of Mechanisms 9
  - 24-391/392 Mechanical Engineering Project Var.
  - 24-436 Intermediate Stress Analysis 10
  - 24-451/452/453 Feedback Control Systems 12
  - 24-655 Cellular Biomechanics 9
  - 24-657/658/659 Molecular Biomechanics 9
  - 24-661 Vibration of Linear and Dynamic Systems 12

- **Thermal-Fluid Systems**
  - 24-324/325 Energy and Thermal Systems Analysis 9
  - 24-331 Viscous Flow 10
  - 24-332/333 Potential Flow Aerodynamics 9
  - 24-421 Internal Combustion Engines 12
  - 24-422/423/424 Special Topics: Energy System Modeling 9
  - 24-424 Energy and the Environment 9
  - 24-425/426 Combustion and Air Pollution Control 9
  - 24-615/616/617 Microfluidics 12
  - 24-616 Tribology-Friction, Lubrication and Wear 12
  - 24-623/624/625 Molecular Simulation of Materials 12
  - 24-642/643/644 Fuel Cell Systems 12

We regularly offer these courses and/or new options according to our teaching schedule. However we cannot guarantee to offer a particular course in a given semester.

Students can also take certain mechanical engineering graduate courses to fulfill the technical elective requirement. However, students must have the appropriate prerequisites and the instructor must approve taking the course. Students can find a list of graduate courses we offer on our website.

Students cannot use the research or project courses to fulfill the technical elective requirement. However, they can use these courses to fill the remaining five elective slots. Courses that do not fulfill the technical elective requirements are:

- 24-391/24-392 Mechanical Engineering Project
- 24-491/24-492 Research Honors
- 39-xxx CIT series courses

Electives

Students must complete five elective courses, as indicated in the example course sequence. Students can take either technical or non-technical courses to fulfill these five slots from either the mechanical engineering department, College of Engineering, or any other Carnegie Mellon department. However, students may only use one elective slot for a physical education course or for ROTC. We offer these electives so students can pursue individual interests or obtain a minor or double major.

Constructing a Program of Study

In order to properly plan their course sequence, students should select their six elective courses with the department academic advisor. If students are pursuing minors, double majors, or double degrees, they should choose electives that meet requirements of these programs. We provide more information on selecting courses and electives in the Undergraduate Student Handbook. We offer the following options to students for tailoring our program to fit their needs and interests.

Specialization Within Mechanical Engineering

Students can specialize in a specific area by taking additional mechanical engineering electives beyond the one required technical elective. Students can choose courses from the Mechanical Engineering Technical Electives list or take approved mechanical engineering graduate courses.

Research and Independent Study Projects

Students can work on a design or research project if supervised and coordinated by a faculty advisor. Interested students should contact faculty members to identify potential projects of mutual interest. Projects generally involve lab, analytical, field, design or computer work.

Students complete projects and research by taking either or both of the following courses for their electives. As previously mentioned, students cannot use these courses to fulfill the technical elective requirement.

- 24-391/24-392 Mechanical Engineering Project Var.
- 24-490/491/492 Department Research Honors Var.

Qualified students enrolled in 24-391/392 do not have an additional GPA requirement for this course.

Developing a Concentration of Interdisciplinary Studies

Students can also take courses outside of mechanical engineering to fill elective slots. Usually students select courses around a common theme; although courses span several departments, students choose courses to form a specific concentration. Students can either construct an informal program of study based on their interests or they can pursue a minor or double major using these courses.

Pursuing a Minor or Double Major

The College of Engineering offers designated minors for students wishing to specialize in an engineering area. Students can find a list of minors on the CIT website (www.cit.cmu.edu). Students can generally complete a designated minor without increasing the number of units required for graduation, but they should plan early in order to complete a minor on time.

Students can also complete a double major within the College of Engineering. Students can earn double majors in Mechanical Engineering and Engineering and Public Policy, or Mechanical Engineering and Biomedical Engineering.

Additionally, students can pursue minors or double majors with other Carnegie Mellon departments. Interested students should contact the main department of the minor/double major they seek to learn the requirements for that program.

Advising

The department academic advisors are assigned initially to all new students and will continue to assist with any curriculum questions and registration issues until they graduate.

The department academic advisors will:

- Verify progress toward degree requirements
- Discuss course alternatives for CIT requirements and electives
- Register research credit
- Assist with pre-requisite waivers
- Offer basic information regarding double major/minors, study abroad procedures, etc
- Explain summer transfer credit policies

Faculty mentors will:

- Explain technical content of coursework
- Suggest appropriate concentrations that match students’ career objectives
- Discuss research opportunities
- Offer graduate school and employment advice
- Offer general advice and mentoring

Students should attend the fall sophomore lunch to meet professors, utilize introductions during sophomore core classes and check the website for additional faculty information. Faculty appointments as needed, may also be arranged through the academic advising office. The academic advisor will
assign a faculty mentor to students that have not indicated a selection at
the end of the sophomore year.

As a regular part of monitoring progress toward completion of the degree,
students should compare their transcripts with the department’s degree
requirements. Academic Audit - the HUB website- www.cmu.edu/hub.

Accelerated Graduate Program (AGP)
We offer an accelerated graduate program to CIT undergraduate students
interested in completing the M.S. in Mechanical Engineering- Course Option
degree. Exceptional students can apply to the program at the end of their
first semester as a junior. We can only admit students who meet all of
the program’s admissions requirements, refer to the AGP website (http://
www.cmu.edu/me/undergraduate/accelerated-master.html) for criteria.

Students are able to complete the M.S. degree in conjunction with their
B.S. degree if they do it in eight semesters. These students will be charged
undergraduate tuition and are able to use their undergraduate financial aid.
Students may also take nine or ten semesters to complete the M.S. degree.
These students will be graduate students and charged graduate student
tuition after the eighth semester. We do not offer financial aid for graduate
students pursuing a M.S. degree. Interested students should contact the
AGP advisor for further information.

Students in the Accelerated Graduate Program must:
• Complete at least 24 units of graduate coursework by the end of their
senior year.
• Obtain a QPA of at least a 3.0 in these courses.
• Do not use these courses to satisfy their B.S. requirements.
• If necessary, complete up to 12 units of 24-793 Supervised Reading and/
or 24-794 Master of Science Project in the summer immediately following
their senior year.
• Complete a total of 96 units to fulfill the M.S. Course Option
requirements.

Quality Point Average Requirements
In addition to the College of Engineering’s requirement of a cumulative
quality point average (QPA) of 2.00 or higher for all courses taken after
the freshman year, the Mechanical Engineering Department requires that
students attain a quality point average of 2.00 or higher for all required
Mechanical Engineering courses.

Pursuant to university rules, students can repeat a course in which a grade
below C was attained in order to achieve the QPA requirement. The highest
dergon grade so obtained will be used to calculate the quality point average for all
required Mechanical Engineering courses.

Full-Time Faculty
ADNAN AKAY, Lord Professor – Ph.D, North Carolina State University;
Carnegie Mellon, 1992–.

CRISTINA HORTENSIA AMON, Lane Distinguished Professor – D.Sc.,
Massachusetts Institute of Technology; Carnegie Mellon, 1988–.

SHELLEY ANNA, Associate Professor – Ph.D, Harvard University;
Carnegie Mellon, 2003–.

JACK LEE BEUTH, Professor – Ph.D, Harvard University; Carnegie Mellon,
1992–.

MAARTEN P. DE BOER, Associate Professor – Ph.D, University of Minnesota;
Carnegie Mellon, 2007–.

JONATHAN CAGAN, George Tallman and Florence Barrett Ladd Professor –
Ph.D, University of California, Berkeley; Carnegie Mellon, 1990–.

STEVEN COLLINS, Assistant Professor – Ph.D, University of Michigan;
Carnegie Mellon, 2010–.

C. FRED HIGGS III, Professor – Ph.D., Rensselaer Polytechnic Institute;
Carnegie Mellon, 2003–.

LEVENT BURAK KARA, Associate Professor – Ph.D., Carnegie Mellon
University; Carnegie Mellon, 2007–.

PHILIP R. LEDUC, Professor – Ph.D., The Johns Hopkins University; Carnegie
Mellon, 2002–.

SHAWN LITSTER, Assistant Professor – Ph.D, Stanford University; Carnegie
Mellon, 2008–.

CARMEL MAJIDI, Assistant Professor – Ph.D, University of California,
Berkeley; Carnegie Mellon, 2011–.

JONATHAN A. MALEN, Assistant Professor – Ph.D, University of California,
Berkeley; Carnegie Mellon, 2009–.

ALAN J.H. MCGAUGHEY, Associate Professor – Ph.D., University of Michigan;
Carnegie Mellon, 2005–.

JEREMY J. MICHALEK, Associate Professor – Ph.D., University of Michigan;
Carnegie Mellon, 2005–.

O. BURAK OZDOGANLAR, Professor – Ph.D, University of Michigan; Carnegie
Mellon, 2004–.

ALBERT PRESTO, Assistant Research Professor – Ph.D, Carnegie Mellon
University; Carnegie Mellon, 2012–.

YOED RABIN, Professor – D.Sc., Technion-Israel Institute of Technology;
Carnegie Mellon, 2000–.

ROBERT REID, Associate Teaching Professor – Ph.D, Carnegie Mellon
University; Carnegie Mellon, 2012–.

ALLEN L. ROBINSON, Professor – Ph.D., University of California, Berkeley;
Carnegie Mellon, 1998–.

EDWARD STEPHEN RUBIN, Professor – Ph.D., Stanford University; Carnegie
Mellon, 1969–.

SHENG SHEN, Assistant Professor – Ph.D, Massachusetts Institute of
Technology; Carnegie Mellon, 2011–.

KENJI SHIMADA, Theodore Ahrens Professor of Engineering – Ph.D.,
Massachusetts Institute of Technology; Carnegie Mellon, 1996–.

SATBIR SINGH, Assistant Teaching Professor – Ph.D, University of Wisconsin-
Madison; Carnegie Mellon, 2012–.

METIN SITTI, Professor – Ph.D., University of Tokyo; Carnegie Mellon, 2002–.

PAUL SETH STEIF, Professor – Ph.D., Harvard University; Carnegie Mellon,
1983–.

RYAN SULLIVAN, Assistant Professor – Ph.D., University of California at San
Diego; Carnegie Mellon, 2012–.

SHI-CHUNE YAO, Professor – Ph.D., University of California, Berkeley;
Carnegie Mellon, 1977–.

DONGHUYEON YANG, Assistant Professor – Ph.D., Stanford University; Carnegie
Mellon, 2009–.

YONGJIE ZHANG, Associate Professor – Ph.D, University of Texas at Austin;
Carnegie Mellon, 2007–.

Adjunct Faculty
JOHN WILLIAM WISS, Adjunct Professor of Mechanical Engineering – M.ME,
Rensselaer Polytechnic Institute; Carnegie Mellon, 1982–.

Emeriti
NORMAN CHIGIER, Professor of Mechanical Engineering, Emeritis – Sc.D.,
University of Cambridge; Carnegie Mellon, 1981–.

JERRY HOWARD GRIFFIN, William J. Brown Emeritus Professor – Ph.D.,
California Institute of Technology; Carnegie Mellon, 1981–.

JOHN FLETCHER OSTERLE, Theodore Ahrens Professor of Mechanical
Engineering, Emeritus – D.Sc., Carnegie Institute of Technology;
Carnegie Mellon, 1946–.

WILFRED THOMAS ROULEAU, Professor of Mechanical Engineering, Emeritus
– Ph.D., Carnegie Institute of Technology; Carnegie Mellon, 1954–.
Department of Materials Science and Engineering

Gregory S. Rohrer, Head Office: Wean Hall 3327
http://materials.cmu.edu

Essentially every technology depends on materials development and innovation. Novel technologies are often initiated based on materials innovations, while conventional technologies rely on materials development to either reduce production cost or respond to mandates of the marketplace. The overarching paradigm of materials science and engineering is to exploit the connection between processing, atomic structure and microstructure, and the properties of a material in order to choose a material that will fit the performance criteria for a given application. Thus, in Materials Science and Engineering, one must develop: (1) an understanding of current materials and their applications; (2) an ability to further improve current materials; and, (3) an ability to understand the potential applications of new materials, as they are developed. In addition to this product specific knowledge, a Materials Engineer must understand the implications of Materials processing routes on the environment and energy resources and must be involved in life cycle analysis to ensure that the material can be properly produced, used and recycled in a sustainable manner.

Materials Science & Engineering is therefore the discipline that applies the tools of basic and applied science to the processing, manufacture and application of materials and devices. Graduates of the MSE department are pursuing careers in an expanding spectrum of companies, national laboratories, and universities. Their activities cover a wide range of materials related endeavors that include microelectronics, energy production and storage, biomedical, biotechnology, aerospace, information technology, nanotechnology, manufacturing and materials production. Our undergraduates are encouraged to participate in the current research programs of the faculty and a majority of our students conduct undergraduate research projects as part of their program.

Materials subjects fall into three broad areas: (1) materials characterization, (2) the synthesis and processing of materials in order to obtain desired properties, and (3) the ability to understand and predict the behavior of materials under diverse conditions. Due to the need to understand materials micro-structure, chemistry and properties, students in Materials Engineering learn techniques of materials characterization in the digital microscopy classroom (http://materials.cmu.edu/degraef/MCL.shtml) in the J. Earl and Mary Roberts Materials Characterization Laboratory, a state of the art facility for materials characterization within the department.

Materials Science and Engineering is the overarching term describing specific interests in metals, polymers, ceramics, composites and electronic materials. It has become increasingly clear that the properties of all these types of materials are related fundamentally through parameters that describe internal structure. Furthermore, it has been found that the equipment and instrumentation, as well as the theoretical and analytical tools, which are necessary to process, study and understand one type of material are often well suited for others. Thus a common set of tools and understanding has been developed that applies to the complete spectrum of materials types, including ceramics, polymers, metals, semiconductors and composites, etc.

The standard curriculum of the department provides fundamental training for all of materials science and engineering areas (http://materials.cmu.edu/ugradlist/fresh.html). The core courses provide understanding and tools for working with the (atomic) structure of materials and the defects (dislocations, interfaces etc.) that largely govern their properties, the thermodynamic relationships that govern the stability of materials, and the rates at which changes take place in materials. The paradigm of materials science is that one must understand the internal or surface structure of materials in order to predict and engineer their properties: this is addressed in the core courses on “Micro-structure & Properties” and “Selection & Performance” of materials. There is also a capstone design experience in the final year that is aimed at integration of knowledge and team skill development. The elective program allows the attainment of excellence in a student’s chosen specialty, whether it is ceramics, semiconductors, metals, composites, magnetic or optical materials, bio-materials or polymers. The option of concentration in the one or more of the areas of electronic materials*, engineering design*, biomedical engineering*, environmental engineering*, manufacturing engineering*, mechanical behavior of materials*, biomedical and health engineering*, and engineering and public policy**, is available. (*= Designated Minor, **= Double Major). In addition, a number of elective tracks have been developed to aid the student in choosing various courses of specialization in the electives.

Based on the broad range of destinations for graduates of the MSE program, our curriculum is designed to provide a strong foundation in fundamental knowledge and skills. This provides an excellent basis for the substantial fraction of our graduates who go on to graduate school. For the equally substantial fraction of our graduates who find employment in industry, the program provides the foundation on which a graduate can build his/her domain specific knowledge. For those individuals who move on to other areas, the MSE curriculum provides a modern liberal education, i.e. one that inculcates a thoughtful, problem-solving approach to professional life. It is thus the goal of our education to provide a general education in Materials Science and Engineering that will enable our graduates to easily switch between materials industries as their career develops or to go to any of the leading institutions of graduate education in Materials and be successful.

Accreditation
The MSE Undergraduate Program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Educational Objectives
The faculty of the Department of Materials Science and Engineering, in consultation with students, alumni and other interested parties, has decided that the overarching objective of the MSE curriculum is to provide an education that enables our graduates to be productive and fulfilled professionals throughout their careers. Specifically, our program will produce graduates who:

1. are successful in a top graduate school and/or in materials science & engineering positions;
2. excel in professionalism and leadership in modern interdisciplinary materials engineering practice, while accounting for the impact of their profession on an evolving society;
3. creatively advance our collective understanding of the principles of materials science and engineering and/or innovate the design of technological systems;
4. contribute effectively as an individual, team member, and/or a leader to achieve personal, group and institutional goals.

Based on these objectives, our program is focused to allow our students to be successful regardless of their future career choice.

Student Outcomes
The Materials Science and Engineering Program has the following student outcomes to prepare graduates to attain the program educational objectives:

**MSE Outcome A:**
An ability to apply a knowledge of mathematics, science and engineering

**MSE Outcome B:**
An ability to design and conduct experiments, as well as to analyze and interpret data

**MSE Outcome C:**
An ability to design a system component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

**MSE Outcome D:**
An ability to function on multidisciplinary teams

**MSE Outcome E:**
An ability to identify, formulate, and solve engineering problems

**MSE Outcome F:**
An understanding of professional and ethical responsibility

**MSE Outcome G:**
An ability to communicate effectively
MSE Outcome H:
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

MSE Outcome I:
A recognition of the need for, and ability to engage in life-long learning.

MSE Outcome J:
A knowledge of contemporary issues.

MSE Outcome K:
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Industrial Intern Program
An industrial internship option (IIO - cooperative educational program) within the department offers an MSE student an opportunity to obtain valuable experience and insight from alternating periods in industry and on campus (beginning the spring after the sophomore year). The combination of learning while participating in an industrial environment with academic course work creates strongly motivated students and a personalized learning situation. Graduation with a B.S. degree occurs four and one-third calendar years after entering the university. Exceptionally able students may be admitted to a program leading to both the B.S. and M.S. degrees in five years. Students in the IIO program should consult with their faculty advisors before electing to participate in any of the designated minor programs.

Following the standard or industrial internship programs the graduate of the Department of Materials Science and Engineering is well prepared for leadership in our highly technological society which continues to demand more and more from the materials used in engineered systems. Many of our graduates elect to continue their education to the Master’s and Doctoral Level in order to satisfy their need for advanced education in the discipline.

Standard Program
Freshman Year
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Junior Year
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Senior Year
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Notes on the Curriculum
Quality Point Average
In addition to the College requirement of a minimum cumulative quality point average of 2.00 for all courses taken beyond the freshman year, the Department requires a quality point average of 2.00 or higher in courses taken in the MSE department. Students may repeat a course to achieve the QPA requirement. Only the higher grade will be used for this departmental calculation.

MSE Restricted Electives
The MSE Restricted Electives are listed below. Each student in the Standard or Industrial Internship program must take at least 45 units from this list. In double major programs at least 36 units are required. The total number of units may be reached through any combination of the courses below.

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<tr>
<th>Units</th>
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<tr>
<td>27-323</td>
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<td>27-565</td>
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</table>
### MSE graduate courses may also be counted as restrictive electives subject to approval by Undergraduate advisors.

#### Industrial Internship Option (Cooperative Education Program)

The industrial internship option (IIO) unique to the Department offers the student in Materials Science and Engineering an opportunity to supplement the regular academic program with valuable practical experience through alternating periods in industry and on campus, beginning in the Spring of the sophomore year. Interested students should apply for this option during the first semester of the sophomore year and are expected to follow the program, including four industry periods, to completion.

#### Standard Program

##### Sophomore Year

**Fall**
- Standard Program for the Fall semester; co-op interviews in Fall

<table>
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<td>xx-xxx Dietrich College Elective [8]</td>
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<tr>
<td>09-105 Introduction to Modern Chemistry</td>
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<td>09-101 Introduction to Experimental Chemistry</td>
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<td>27-xxx MSE Restricted Elective [1]</td>
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<td>27-216 Transport in Materials</td>
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<tr>
<td>27-217 Phase Relations and Diagrams</td>
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<tr>
<td>27-205 Introduction to Materials Characterization</td>
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| xx-xxx Free Elective [1] | 9 |
| 33-225 Quantum Physics and Structure of Matter | 9 |
| or 09-217 Organic Chemistry I | 9 |
| or 03-121 Modern Biology | 9 |
| 27-399 Professional Development II | 1 |

<table>
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<tr>
<td>36-220 Engineering Statistics and Quality Control</td>
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<td>27-367 Selection and Performance of Materials</td>
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| 27-499 Professional Development III | 1 |
| 27-401 MSE Capstone Course I | 12 |

Minimum number of units required for degree: 379

* The 5 MSE Restricted Electives are listed above as 9 unit courses. The student must complete at least 45 units of MSE Restricted Electives, and may combine 6 and 9 unit courses to reach or exceed this total.

** See remark after Standard Program.

#### Integrated B.S./M.S. Program

Undergraduates who excel academically have the unique opportunity to receive simultaneously or sequentially both B.S. and M.S. degrees from the department. The primary purpose of the Integrated Master and Bachelor (IMB) Degree Program is to provide students with superior breadth and depth in technical material, which will better prepare them for careers in industry. Students interested in pursuing the IMB Degrees are encouraged to begin taking some of the required graduate courses before their last year. The MSE department offers two M.S. degrees: one in Materials Science and Engineering (MSE), a coursework degree, and one in Materials Science (MS), a coursework + research degree. The IMB Degree Program to obtain an M.S. in MSE (MS) degree normally requires two (three to four) additional full academic semesters of coursework (coursework + research) beyond the B.S. Degree Requirements (normally eight academic semesters). Experience has shown that students complete the IMB program in eight to ten full academic semesters after enrolling at CMU.

#### Degree Requirements

IMB students can be enrolled in either the M.S. in MSE (coursework) or the M.S. in MS (coursework + research) degree programs, depending on their preference. Students must meet the requirements of either the M.S. in MSE or the M.S. in MS degree programs, as well as any specially stated rules below. 

#### Eligibility

The IMB Program is available to all undergraduates who maintain a cumulative GPA of 3.0 or better, including the freshman year and the years in which they are enrolled in the IMB. Exceptions can be made by the Department on the basis of other factors, including extenuating (e.g., medical) circumstances, improvement in grades, strong recommendation letters, etc.

Students become eligible to apply to the program during the spring semester of their junior year (5th semester), or the semester in which they accumulate 280 or more units, whichever is earlier.

#### Enrollment

Students interested in the IMB program are not required to follow the formal application process for acceptance into the MSE graduate program. There is no requirement to provide a formal application, application fee, GRE scores, recommendation letters, official transcripts, or a statement of purpose.

Interested students are encouraged to request acceptance into the program by contacting the Department Head of MSE by email prior to the middle of the semester in which they become eligible.

#### Requirements to Enroll as a Graduate Student

If a student takes more than 8 semesters to complete both the B.S. and M.S. in MSE (coursework), then he or she must be a graduate student for at least
one full-time 15-week academic semester (Fall or Spring) before graduating, whether or not they have already completed their B.S. degree.

If a student takes more than 8 semesters to complete both the B.S. and M.S. in M.S (coursework + research), then he or she must be a graduate student for at least two full-time 15-week academic semesters (Fall or Spring) before graduating, whether or not they have already completed their B.S. degree.

Tuition Assistance

When a student is a full-time graduate student through the IMB program, the department is able to provide some tuition assistance through optional Teaching Assistantships.

Additional Information

Once the student has been accepted, the student should meet with his or her IMB academic advisor(s) to determine a course schedule. The student must indicate departmental program coordinator at which point they intend, if necessary, to register as a graduate student. Once a student in the IMB program has completed all of the requirements for the B.S. degree, he or she should become a graduate student.

To determine the most appropriate time for an undergraduate student to become a graduate student, he or she should consult with Enrollment Services to understand how becoming a graduate student will affect financial aid.

Faculty

CHRIS BETTINGER, Assistant Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2010–.

MICHAEL BOCKSTALLER, Associate Professor – Ph.D., Max-Planck Institute for Polymer Research; Carnegie Mellon, 2005–.

ROBERT F. DAVIS, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–.

MAR C DE GRAEF, Professor – Ph.D., Catholic University Leuven (Belgium); Carnegie Mellon, 1993–.

ADAM FEINBERG, Assistant Professor – Ph.D., University of Florida; Carnegie Mellon, 2010–.

RICHARD J. FRUEHAN, Professor – Ph.D., University of Pennsylvania; Carnegie Mellon, 1981–.

WARREN M. GARRISON, Professor – Ph.D., University of California at Berkeley; Carnegie Mellon, 1984–.

ROBERT HEARD, Associate Teaching Professor – Ph.D., University of Toronto; Carnegie Mellon, 2003–.

ELIZABETH A. HOLM, Professor – Ph.D., University of Michigan; Carnegie Mellon, 2012–.

MOHAMMAD F. ISLAM, Assistant Professor – Ph.D., Lehigh University; Carnegie Mellon, 2005–.

DAVID E. LAUGHLIN, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1974–.

MICHAEL E. MCHENRY, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1899–.

YOOSUF PICARD, Assistant Research Professor – Ph.D., University of Michigan; Carnegie Mellon, 2009–.

P. CHRIS PISTORIUS, Professor – Ph.D., University of Cambridge; Carnegie Mellon, 2008–.

LISA M. PORTER, Professor – Ph.D., North Carolina State; Carnegie Mellon, 1997–.

GREGORY S. ROHRER, Professor and Head – Ph.D., University of Pennsylvania; Carnegie Mellon, 1990–.

ANTHONY D. ROLLETT, Professor – Ph.D., Drexel University; Carnegie Mellon, 1995–.

PAUL A. SALVADOR, Professor – Ph.D., Northwestern University; Carnegie Mellon, 1999–.

SRIDHAR SEETHARAMAN, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000–.

MAREK SKOWRONSKI, Professor – Ph.D., Warsaw University; Carnegie Mellon, 1988–.

ELIAS TOWE, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001–.

JAY WHITACRE, Assistant Professor – Ph.D., University of Michigan; Carnegie Mellon, 2007–.

Emeriti Faculty

THADDEUS B. MASSALSKI, Professor Emeritus of Physics, Materials Science and Engineering – Ph.D., D.Sc., University of Birmingham, England D.Sc. (h), University of Warsaw, Poland.; Carnegie Mellon, 1959–.

HAROLD W. PAXTON, University Professor and U.S. Steel Professor Emeritus of Materials Science and Engineering – Ph.D., University of Birmingham, England; Carnegie Mellon, 1986–.

HENRY R. PIEHLER, Professor of Materials Science and Engineering, and Public Policy – D.Sc., Massachusetts Institute of Technology; Carnegie Mellon, 1967–.

PAUL WYNBLATT, Professor Emeritus of Materials Science and Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 1981–.

Affiliated Faculty

AMIT ACHARYA, Associate Professor, Civil and Environmental Engineering – Ph.D., University of Illinois, Urbana-Champaign; Carnegie Mellon, 2000–.

JAMES BAIN, Associate Professor, Electrical and Computer Engineering – Ph.D., Stanford University; Carnegie Mellon, 1993–.

JACK BEUTH, Professor, Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 1992–.


KRIS NOEL DAHL, Assistant Professor of Chemical Engineering and Biomedical Engineering and Materials Science and Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006–.

RANDALL FEENSTRA, Professor, Physics – Ph.D., California Institute of Technology; Carnegie Mellon; Carnegie Mellon, 1995–.

STEPHEN GAROFF, Professor, Physics – Ph.D., Harvard University; Carnegie Mellon, 1988–.

ANDREW GELLMAN, Lord Professor, Chemical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992–.

DAVID W. GREVE, Professor, Electrical and Computer Engineering – Ph.D., Lehigh University; Carnegie Mellon, 1982–.

DAVID KINDERLEHRER, Professor, Mathematical Sciences – Ph.D., University of California, Berkeley; Carnegie Mellon, 1990–.

JOHN KITCHIN, Assistant Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2006–.

TOMEK KOWALIEWSKI, Professor of Chemistry – Ph.D., Polish Academy of Sciences; Carnegie Mellon, 2000–.

DAVID LAMBETH, Professor, Electrical and Computer Engineering and Materials Science and Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1999–.

JONATHAN MALEN, – Ph.D., University of California, Berkeley; Carnegie Mellon, 2009–.

KRZYSZTOF MATYJASZEWSKI, J.C. Warner Professor of Natural Sciences, Department of Chemistry and Materials Science and Engineering – Ph.D., Polytechnical University of Lodz, Poland; Carnegie Mellon, 1985–.

ALAN McGAUGHEY, – Ph.D., University of Michigan; Carnegie Mellon, 2005–.

JAMES MILLER, Research Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006–.

O. BURAK OZDOGANLAR, Assistant Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2004–.

ROBERT SEKERKA, University Professor, Physics, Mathematics and Materials Science – Ph.D., Harvard; Carnegie Mellon, 1969–.

ROBERT SU TERA, Professor, Physics – Ph.D., Clark University; Carnegie Mellon, 1981–.

LYNN WALKER, Associate Professor, Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1997–.

NE WEL R. WASHBURN, Assistant Professor of Chemistry, Biomedical Engineering and Materials Science and Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–.

LEE WEISS, Principal Research Scientist, ICES – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–.
MICHAEL WIDOM, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1985–.

JIAN-GANG ZHU, Professor, Electrical and Computer Engineering – Ph.D., University of California at San Diego; Carnegie Mellon, 1997–.
The School of Drama offers a highly focused, world-class theatre education with thorough preparation for sustained careers and innovation in today’s widely-varied entertainment industries. The undergraduate programs lead to BFA degrees in Drama, with focuses in Acting, Music Theatre, Directing, Dramaturgy, Design, Production Technology and Management; MFA programs are offered in Scene, Costume, Sound, and Lighting Design; Directing; Dramatic Writing; and Production Technology and Management.

Music Office: CFA 105
The School of Music has as its goal the preparation of musicians for careers in performance, composition, conducting and teaching. The program provides the opportunity to study with world-class artists utilizing the best aspects of conservatory training in the context of a major research university, combining the educational with the intensely professional. Undergraduate degrees are offered in Music Composition and Music Performance with minors in Accompanying, Conducting, Music Education, Music Performance, and Music Technology available. The Master of Music is offered in Composition, Performance, Conducting and Music Education.

BXA Intercollege Degree Program
Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), Bachelor of Computer Science and Arts (BCSA)
Franco Sciannameo, Director
Location: Solar House
www.cmu.edu/interdisciplinary
The Bachelor of Humanities and Arts (BHA) is a four-year intercollege degree-granting program designed for students interested in blending studies in the College of Fine Arts and the College of Humanities and Social Sciences. The BHA degree combines a General Education requirement, a concentration of courses in the College of Fine Arts, a concentration of courses in the College of Humanities and Social Sciences, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Bachelor of Science and Arts (BSA) is a four-year intercollege degree-granting program designed for students interested in combining studies in the College of Fine Arts and the Mellon College of Science. It combines General Core requirements, a concentration of courses in the College of Fine Arts, a concentration of courses in the Mellon College of Science, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Bachelor of Computer Science and Arts (BCSA) is a four-year intercollege degree-granting program designed for students interested in pursuing fields that comprehensively meld technology and the arts through courses offered in the College of Fine Arts and the School of Computer Science. It combines General Core requirements, a concentration of courses in the College of Fine Arts, a concentration of courses in the School of Computer Science, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Master of Arts Management Program
1116 Hamburg Hall
The search for both increased support and larger audiences has intensified over the last decade and now, more than ever, arts organizations seek skilled managers. To meet this need, the College of Fine Arts and the Heinz College jointly developed the Master of Arts Management (MAM) Program to provide strong leadership in theater companies, dance companies, orchestras, opera companies, and visual arts organizations. In addition to the traditional two-year graduate degree structure, the Master of Arts Management Program provides undergraduate students the opportunity to
complete the Bachelor of Fine Arts and Master of Arts Management degrees within a period of five years through the Heinz College's Accelerated Masters Program (AMP). MAM Program alumni can be found managing music and arts service organizations; marketing orchestras, theaters and dance companies; fund-raising for museums, opera companies, ballet companies and public television stations; and managing the finances of university arts departments and private businesses working in the arts and entertainment industry.

Student Defined Majors in the College of Fine Arts

To apply for a Student Defined Major in the College of Fine Arts, one:

1. Must be a student in good standing in the University and have completed at least one semester successfully.
2. Must have a cumulative QPA of 2.75 or better. A student whose QPA is under 2.75 may still submit a proposal. If the proposal is accepted by the Associate Deans, the student must apply for transitional status for the following semester and will have 1 semester to improve his or her QPA to the 2.75 minimum. If the student is not successful in raising the QPA to the 2.75 minimum, he or she may lose the affiliation with the current home department in the College of Fine Arts. If this happens the student must either be re-admitted back into the old program or seek admittance into another department or college.
3. Must have a statement of purpose that explains how and why the proposed course of study will be the best way for the student to receive an education and degree from Carnegie Mellon. This statement should detail the academic backbone of the program and project possible career paths after graduation.
4. Must outline the proposed courses to be taken and the semester in which they might be taken.
5. Must have a faculty mentor in the College of Fine Arts who has agreed to mentor the student through the completion of the degree. This mentor should be from the school where the student is taking the majority of his or her courses, and be approved by the Associate Deans.
6. Once the proposal has been submitted to the Associate Deans and they have reviewed it, the student will be required to go to the academic advisors in the school/schools where he or she will be taking courses and have them sign-off on the courses which are specific to their schools. Once the student has obtained all the necessary signatures, the completed proposal should be returned to CFA 100 for final review and approval by the Associate Deans.

All signed documentation should be submitted to the Office of the Dean of Fine Arts, CFA 100, by the first Monday in November in the fall semester, and by the last Monday in March in the spring semester. The proposal will be considered by the Associate Deans of the College, in consultation with the appropriate School Heads and Academic Advisors. Proposals that come in after these dates will not be considered, but may be re-presented until the following semester. In that case, the student has the option to become a transitional student for a semester.

Under most circumstances the degree conferred at graduation will be a Bachelor of Arts. To continue in the program a student must show academic progress toward the degree. The academic actions of the College will apply to all student-defined majors. The Office of the Dean, in consultation with the faculty mentor and academic advisor, will determine certification of the degree.

Student Organizations

Professional and honorary societies for students in the College of Fine Arts are the American Institute of Architects, Tau Sigma (honorary for students in architecture), Alpha Rho Chi (architectural award for leadership), the Student Design Forum (SDF), American Institute of Graphic Arts (AIGA), Industrial Designers Society of America (IDSA), United States Institute for Theatre Technology (USITT), Phi Mu Alpha Sinfonia (music fraternity for men), Sigma Alpha Iota (music sorority for women), Pi Kappa Lambda (honorary for students in music) and the Music Educators' National Conference.

Academic Standards

Grading Practices

Grades given to record academic performance in the College of Fine Arts are detailed in the catalog section entitled "Undergraduate Academic Regulations." All courses taught by the schools in the College of Fine Arts follow the standard letter grade system of the university. Responsibility for the grade given the student rests entirely with the instructor and the school concerned. A permanent grade may not be raised by taking a second examination. Students who wish to repeat a course already passed must obtain approval from the Dean of the College. At the time of approval, the Dean will decide in the light of circumstances whether the new grade or the old grade will be the official grade used as the computing factor for honors. Both grades, however, will appear on the official transcript.

Academic Actions

The decision to impose academic action is first initiated at the conclusion of each semester by the School faculty most involved in the student’s primary area of study and then presented at the end of the semester to the Academic Actions sub-committee of the College Council for confirmation. A student who is not making satisfactory progress toward meeting professional standards or toward completing graduation requirements in a School may have any of the academic actions listed below imposed by that School even though the student has received “passing” grades.

The academic actions listed below do not follow a particular sequence; any of the actions may be appropriately imposed at any time upon recommendation of the School faculty concerned and confirmation by the College Council.

Warning: For failure to maintain professional standards in a required course; or insufficient evidence of serious application to the professional standards of the School; or an overall quality point average below a satisfactory level. Warning action is intended to notify the student of unsatisfactory performance, and to suggest that the student take steps to determine and correct the cause of the difficulty.

Probation: For failure to pass any professional course as outlined by the faculty of the School; or failure to meet the professional standards of the School although no failing grades are given; or failure to earn the minimum quality point average required to continue in the School. A student on probation may be required to achieve a specified quality point average. The student must improve scholastic standing to an acceptable level in order to be removed from Probation. A student not doing so may be Suspended or Dropped at the end of the semester.

Final Probation: For significantly poor performance, or for continued failure to meet the professional standards of the School. The student must improve scholastic standing to an acceptable level in order to be removed from Final Probation. A student not doing so may be Suspended or Dropped at the end of the semester. This action may be taken without previous academic action.

School Suspension: For poor performance, or for personal problems that create an impediment to professional achievement in the School. A student is suspended from the School, but not the University, when it is deemed in the best interest of the student to allow continuation of study outside of the School during the period of the suspension. The student is not permitted to take courses in the School for a period to be determined by this faculty action, but will be re-admitted at the end of the period of School Suspension specified by the faculty after the condition of the School Suspension is satisfied.

Drop from the School: A student is Dropped from the School when it is clear that the student’s progress in professional training is insufficient to warrant continuing in the current professional field of study in this College. This action is taken in the case of a student who has been lacking in some essential requirement in the chosen professional field, but whose general scholastic ability, habits and character justify an opportunity in some other field of education. This action terminates the student’s enrollment in the current School, but is not intended to prejudice admission to another Department, School, or College of the University, or to another institution.

This academic action allows the student three choices:

• Transfer to another Carnegie Mellon University Department or School. A student must contact that Department or School of choice to discuss possible transfer.
• Request for Transitional status in the College of Fine Arts for one semester (see below: Transitional Students). A student must make an appointment at the Carnegie Mellon Advising Resource Center in order to pursue this option.
• Withdraw from Carnegie Mellon University. An application for Withdrawal/Leave of Absence form is enclosed with the letter notifying a student of this academic action.

Drop from the College: A student is Dropped from the College when it is clear that the student shows no indication of being able to reach an acceptable level of performance or maintain steady progress toward completing graduation requirements. This action terminates the student’s enrollment in the College of Fine Arts, but is not intended to prejudice admission to another College of the University, or to another institution.

This academic action allows the student three choices:

• Transfer to another Carnegie Mellon University College. A student must contact that College of choice to discuss possible transfer.
• Request for Transitional status in the College of Fine Arts for one semester (see below: Transitional Students). A student must make an appointment at the Carnegie Mellon Advising Resource Center in order to pursue this option.
• Withdraw from Carnegie Mellon University. An application for Withdrawal/Leave of Absence form is enclosed with the letter notifying a student of this academic action.

A student who has been suspended from the University or has withdrawn is required to leave the campus, including residence halls and Greek houses, within a maximum of two days after the action and to remain off campus for the duration of the time specified. This action includes exclusion from part-time and summer study at the University for the duration of the period of the action.

Graduation Requirements
Because of the special nature of work in the College of Fine Arts, the first year in all schools should be considered probationary, a period in which a student and faculty can evaluate professional promise in terms of the college’s standards. Graduation from the College of Fine Arts follows the general university guidelines. As part of a student’s qualification for an undergraduate degree, the equivalent of two terms of full-time work must be pursued under the direction of faculty members in the college during the period immediately prior to the degree award. Courses completed at other institutions will not be acceptable as terminal credit for a degree. Exceptions to this stipulation can be recommended by a school faculty in unusual cases, but the concurrence of the College Council is necessary before final approval of an exception can be given.

Other graduation requirements in the College of Fine Arts are described in the curriculum of each school. Further questions about specific course requirements and the total number of units required should be directed to the respective school advisors.

Other Regulations Affecting Student Status
Schedule Changes
Courses may be added or dropped within the times stated in the college calendar. No courses may be added or dropped after the stated deadline dates except with the approval of the student’s School Head and the Dean of the College. (See http://coursecatalog.web.cmu.edu/servicesandoptions/enrollmentservices/ for Add/Drop procedures.)

Withdrawal/Leave of Absence
Please refer to the Student Leave Policy.

Transitional Students
The designation Transitional Student has been instituted by the Dean of the College of Fine Arts to assist students who have been judged unlikely to make satisfactory progress in their chosen professional field, or who on their own initiative, have changed their mind about their originally chosen field of study. Being a Transitional Student gives them an opportunity to maintain a relationship with the College of Fine Arts while re-orienting career plans and goals. It also gives them time to enhance their admissibility to another school in the college, another college in the university, or another institution. Ordinarily a student will be permitted to register as a Transitional Student for no more than one semester.

Transitional status is made available to students upon the advice of their advisors or upon their own request. A student must make an appointment at the Carnegie Mellon Advising Resource Center to discuss this option.

Transfer Students
Undergraduate students seeking transfer within or to any school of the College of Fine Arts must file an application with the School and proceed with the established transfer application procedure, audition, portfolio review or ASAT requirements. Admission may dictate freshman status regardless of the student’s prior college experience.

Materials
The college does not furnish students with any drawing materials, make-up materials, textbooks, or other expendable equipment except those in courses in which materials fees are charged to cover specific costs.

Retention of Students’ Work
The college reserves the right to retain indefinitely any student work the faculty may select. All work not retained by the faculty must be claimed at the time specified on the bulletin boards of the schools concerned. The college assumes no liability for student materials in its custody.
Minors Offered by the College of Fine Arts

The College of Fine Arts offers minors in Architecture, Art, Design, Drama, and Music to students from other colleges at Carnegie Mellon University. These minors allow students at Carnegie Mellon to take courses and develop a direction for electives in any of the five schools in CFA. Students in the College of Fine Arts may also earn minors outside of their major within other schools in the College. They may also study any of the minors offered by the other colleges to the University at large, thus taking advantage of the broad educational opportunities available at Carnegie Mellon University.

Minors Offered by the College of Fine Arts:
- Architecture
- Architectural History
- Architectural Representation and Visualization
- Art
- Communication Design
- Drama
- History of the Arts
- Industrial Design
- Music
- Music Technology
- Music Theory
- Photography

Guidelines for students are: 1) except where so designated, CFA students are not eligible to earn a minor in their own school; students from outside CFA may earn a minor in any school in CFA; 2) faculty advisors in the student’s home school (in consultation with the academic officer of the other unit involved) will advise students as to the structuring of the courses in each minor; 3) a minor is not to be considered an overload; rather, through the assistance of faculty advisors it should be integrated into a student’s overall units required for graduation; 4) the advisors will also monitor the student’s development in these minors and keep records in their files which indicate the fulfillment of the course requirements in the minors, as well as in the majors in the student’s own school. Courses listed as possible for the minors may be available, but not all courses are offered every semester. Students should consult with their advisors.

Students interested in earning a minor in any of the CFA schools should contact: Architecture: Heather Workinger; Art: Keni Jefferson; Design: Melissa Cicozi; Drama: Ari Blackford; Music: Sharon Johnston.

Minors under Architecture

Minor in Architecture
This sequence is for candidates who intend to develop intellectual links to the architectural profession. The scope of courses offered includes a full spectrum of professional issues in architecture.

Prerequisite Courses 9 units
79-104 Global Histories
or 62-100 Critical Histories of the Arts

Required Courses 18-21 units
48-100 Architecture Design Studio: Foundation I
or 48-095 Spatial Concepts for Non-Architects I
48-240 Historical Survey of World Architecture and Urbanism I

Elective Courses* 27 units
48-130 Architectural Drawing I: A Tactile Foundation
48-135 Architectural Drawing II: Appearance
48-210 Statics
48-215 Materials and Assembly
48-217 Structures
48-351 Human Factors in Architecture
48-452 Real Estate Design and Development
48-453 Urban Design Methods
48-551 Ethics and Decision Making in Architecture
48-xxx Architecture History (Pre-Approval of coursework required)
48-xxx Architecture Elective (Pre-Approval of coursework required)

Minimum Units: 54
*Students should consult the Architecture advisor regarding elective choices.

Minor in Architectural History
This sequence is intended for candidates interested in the history of architecture in its many manifestations, including high style and vernacular buildings, western and non-western traditions, built and theoretical works, and rural to urban contexts. Non-architecture majors are required to take 54 units of architectural history. Architecture majors wishing to minor in Architectural History must fulfill the three core required courses in architectural history, plus four additional architectural history electives, for a total of 63 units. Students wishing to pursue the minor should meet with the Architecture advisor to determine if a course is eligible.

Prerequisite Courses 18 units
48-240 Historical Survey of World Architecture and Urbanism I
62-100 Critical Histories of the Arts

Elective Courses 36 units/45 units
48-338 European Cities in the XIX Century: Planning, Architecture, Preservation
48-340 Modern Architecture and Theory 1900-1945
48-341 History of Architectural Theory
48-343 American Built Environment Since 1860
48-344 Architecture of Henry Hobson Richardson
48-345 The Cultural Landscape of Northern Italy: Land, City, Architecture
48-348 Architectural History of Mexico & Guatemala
48-350 Postwar Modern Architecture and Theory
48-352 A History of Preservation: Debate, Theories and Practices
48-368 Rediscovering Antiquity: Travellers, Archaeologists & Architects in Mediterranean
48-371 American House and Housing
48-440 American Regionalism
48-441 Frank Lloyd Wright
48-447 History and Preservation
48-448 History of Sustainable Architecture
48-xxx Architectural History (Pre-Approval of coursework required)

Minimum Units: 54 (non-architecture majors)
Minimum Units: 63 (architecture majors)

Minor in Architectural Representation and Visualization
This sequence is for candidates who intend to develop particular skills in architectural representation. Architecture majors wishing to pursue a Minor in Architectural Representation and Visualization must complete the required 33 units and at least an additional 30 units to fulfill the minor for a total of 63 units.

Required Courses 33 units
48-120 Introduction to Digital Media I
48-130 Architectural Drawing I: A Tactile Foundation
48-135 Architectural Drawing II: Appearance
48-xxx Architectural Drawing Elective (Pre-Approval of coursework required)

Elective Courses 21 units/30 units
48-125 Introduction to Digital Media II *Architecture majors cannot use 48-125 as an elective requirement
48-477 Undergraduate Making things Interactive
48-568 Advanced CAD, BIM, and 3D Visualization
48-576 Mapping Urbanism
48-724 Parametric Design
48-xxx Architectural Representation/Visualization Elective: (Pre-Approval of coursework required)
48-xxx Architectural Representation/Visualization Elective: (Pre-Approval of coursework required)

Minimum Units: 54 (non-architecture majors)
Minimum Units: 63 (architecture majors)

Minor in Architectural Technology
This sequence is for candidates who intend to develop intellectual links to the technical aspects of the profession. It is not available to B. Arch Candidates.
Prerequisite Courses: 22 units

33-106 Physics I for Engineering Students 12
21-120 Differential and Integral Calculus 10

Elective Courses: 32-40 units

48-116 Building Physics 9
48-210 Statics 9
48-215 Materials and Assembly 9
48-217 Structures 9
48-315 Environment I: Climate & Energy 9
48-412 Environment II: Mechanical Systems 9
48-415 Advanced Building Systems 6
48-xxx Architecture Elective 9

Minimum Units: 54

Minor in Building Science

(Available only to B. Arch Candidates)

This sequence is intended for candidates seeking in depth knowledge in the area of architectural science and for those interested in gaining advanced placement in the M.S. Program offered by the School of Architecture in Building Performance and Sustainable Design.

Required Courses 9 units

48-711 Paradigms of Research in Architecture 9

Elective Courses 45 units

48-596 LEED Buildings and Green Design 6
48-721 Building Controls and Diagnostics 12
48-722 Building Performance Modeling 12
48-723 Special Topics in BPS: Redesigning Our Built Environment Var.
48-729 Productivity, Health and the Quality of Buildings 9-12
48-749 Special Topics in CD: Parametric Modeling with BIM Var.
48-752 Zero Energy Housing 9

Minimum Units: 54

Minors under Art

Minor in Art

Concept Studio (choose one) 10 units

60-101 Concept Studio I 10
60-201 Concept Studio II 10
60-202 Concept Studio III 10

Media Studios (choose two)

60-110 Electronic Media Studio I 10
60-210 Electronic Media Studio II 10
60-130-130 3D Media Studio I and 3D Media Studio II 10
60-131-131 3D Media Studio II and 3D Media Studio II 10
60-150 2D Studio: Drawing 10
60-160 2D Studio: Imaging 10
60-250 2D Studio: Painting 10

Advanced Media (choose two) 20 units

48-xxx Advanced ETB: Electives 10
48-xxx Advanced SIS: Electives 10
48-xxx Advanced PDP: Electives 10
48-xxx Advanced CP: Electives 10

Art History/Theory (choose one) 9 units

60-xxx Art History Elective 9

Minimum units: 59

Minor in the History of Arts

This minor of six or more courses as designated below, will offer students a grouping of Arts History courses that can provide a broad survey in the arts or a highly specialized field. For College of Fine Arts students, all courses meeting the requirements of the Minor in the History of the Arts must be taken outside of their major School, with the exception of the School of Architecture. Interested students should contact Patty Doane in the College of Fine Arts, Room 100.

Introductory Level Courses: 27 units

(choose at least three, CFA students pick 3 outside of major)

48-240 Historical Survey of World Architecture and Urbanism I 9
54-271 Design History I 9
54-239 History of Architecture and Decor -1
54-245 History of Clothing -1
54-246 History of Clothing 1
57-173 Survey of Western Music History 9
60-205 Modern Visual Culture 1789-1945 9
60-206 Contemporary Visual Culture from 1945 to the Present 9

Advanced Courses: 27 units

(choose at least three, CFA students pick 3 outside of major)*

48-340 Modern Architecture and Theory 1900-1945 9
48-341 History of Architectural Theory 9
48-343 American Built Environment Since 1860 9
48-344 Architecture of Henry H. Hornbostel 9
48-345 The Cultural Landscape of Northern Italy, Land, City, Architecture 9
48-348 Architectural History of Mexico & Guatemala 9
48-440 American Regionalism 9
48-441 Frank Lloyd Wright 9
48-447 History and Preservation 9
51-272 Design History II 9
51-378 History of the Book and Printing 6
54-381 Special Topics in Drama: History, Literature and Criticism 6
54-382 History of Drama 3
57-209 The Beas 9
57-477 Music of the Spirit 6
57-478 Survey of Historical Recording 6
57-493 Studio Topics 60-330 to 60-398 (instructor permission only) 9
62/79-360 Photographers and Photography Since World War II 9
62-371/39-372 Photography, The First 100 Years 9
79-395 The Arts in Pittsburgh 9
79-396 Music and Society in 19th and 20th Century Europe and the U.S. 9

minimum units required: 54

* Other courses not on this list may qualify as approved by CFA Dean’s Office (College of Fine Arts, Room 100).

Minors under Design

Minor in Communication Design

This program gives an overview of basic visual communication skills and the concerns of the communication design professions. Entry into the program and course registration is contingent upon your ability to demonstrate an acceptable level of design skills and aptitude through a portfolio review. Students must receive approval and course counseling for a Minor in Communication Design from the Communication Design Faculty Advisor before beginning the sequence of required courses. Through this advising system, a curriculum sequence will be chosen to meet your specific needs and fit within Design’s current course capacities. Applications are reviewed each February.

Required Courses 18 units

51-261 Communication Design Fundamentals 9
57-271 Design History I (fall) 9

Electives Courses 36 units

Elective courses are to be chosen from those listed in the current course catalog. This program description is based on the latest information at the time of publication. Interested students should contact the School of Design regarding any changes in the program and the availability of courses.

minimum units required: 54

Minor in Industrial Design

This program gives an overview of basic design skills and concerns of the product design profession. It is intended to enable students from Engineering, Humanities and Social Science, Management and other colleges to interact effectively with professional Product Designers. Entry into the program and course registration is contingent upon your ability to demonstrate an acceptable level of design skills and aptitude through a portfolio review. Students must receive approval and course counseling for a Minor in Industrial Design from the Industrial Design Faculty Advisor before beginning the sequence of required courses. Through this advising system, a curriculum sequence will be chosen to meet your specific needs and fit within Design’s current course capacities. Applications are reviewed each February.
### Minor in Drama

The Drama minor provides students with a well-rounded opportunity to obtain preliminary professional exposure to the theatre arts. Courses may involve acting, directing, playwriting, design, production technology and management, and dramatic literature courses. Students also become involved with Drama productions by signing up for Production for Non-Majors, which involves evening crew work on various Drama productions.

**Admission Requirements**

1. The student must apply to enter the program in the office of the Drama Sr. Academic Advisor, PCA 223.
2. The student must successfully pass one Drama course prior to being considered for minor status.

<table>
<thead>
<tr>
<th>Required Courses</th>
<th>25 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-163</td>
<td>Production for Non-Majors</td>
</tr>
<tr>
<td>54-164</td>
<td>Production for Non-Majors</td>
</tr>
<tr>
<td>54-175/176</td>
<td>Conservatory Hour</td>
</tr>
<tr>
<td>54-177</td>
<td>Foundations of Drama I</td>
</tr>
<tr>
<td>or 54-178</td>
<td>Foundations of Drama I</td>
</tr>
<tr>
<td>54-281</td>
<td>Foundations of Drama II</td>
</tr>
<tr>
<td>or 54-282</td>
<td>Foundations of Drama II</td>
</tr>
</tbody>
</table>

Students must meet with the School of Drama Production Manager (PCA 224) for assignments related to Production for Non-Majors.

<table>
<thead>
<tr>
<th>Elective Courses</th>
<th>30 units</th>
</tr>
</thead>
</table>

The remainder of the minor is fulfilled with Drama courses of the student’s choosing, with approval from the Sr. Academic Advisor in the School of Drama. For certain courses, students may need instructor permission to register.

<table>
<thead>
<tr>
<th>Elective Courses not requiring instruction permission:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>54-187/188 Introduction to Playwriting</td>
<td>9</td>
</tr>
<tr>
<td>54-189/190 Advanced Playwriting</td>
<td>9</td>
</tr>
<tr>
<td>54-191/192 Acting for Non-Majors</td>
<td>6</td>
</tr>
<tr>
<td>54-193/194 Introduction to Screenwriting</td>
<td>9</td>
</tr>
<tr>
<td>54-195/196 Advanced Screenwriting</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Selected Elective Courses requiring instructor permission:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>54-109 Dramaturgy I: Approaches to Text</td>
<td>9</td>
</tr>
<tr>
<td>54-121 Directing II: Sources</td>
<td>9</td>
</tr>
<tr>
<td>54-157 Basic PTM</td>
<td>6</td>
</tr>
<tr>
<td>54-169 StudioCraft</td>
<td>13</td>
</tr>
<tr>
<td>54-171 Basic Design</td>
<td>6</td>
</tr>
</tbody>
</table>

Additional Drama Courses are available by instructor agreement and may require an audition, interview, or portfolio review. Students should contact the Drama Sr. Academic Advisor to inquire about permission for specific courses in which they are interested.

Minimum units required: 55

### Minor in Music

**Minor in Music**

This sequence is for candidates who are majors from any discipline in the university other than music who have some background in music and would like to know more about music.

**Admission Requirements**

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

<table>
<thead>
<tr>
<th>Required Courses</th>
<th>18 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-264</td>
<td>Industrial Design Fundamentals</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective Courses</th>
<th>36 units</th>
</tr>
</thead>
</table>

Elective courses are to be chosen from those listed in the current course catalog. This program description is based on the latest information at the time of publication. Interested students should contact the School of Design regarding any changes in the program and the availability of the courses.

Minimum units required: 54

<table>
<thead>
<tr>
<th>Prerequisite Course</th>
<th>0-3 units</th>
</tr>
</thead>
</table>

Beginning Piano is required of students who do not pass a piano proficiency test.

<table>
<thead>
<tr>
<th>Required Music Courses</th>
<th>25 units</th>
</tr>
</thead>
</table>

Basic Harmony I and/or Basic Solfege I are required of students who do not qualify for entrance into Harmony I and/or Solfege I, based on their scores on the theory and solfege placement tests.

<table>
<thead>
<tr>
<th>Required Studio Courses (studio fee is charged)</th>
<th>24 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-xxx</td>
<td>Elective Studio</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Elective Studio</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Elective Studio</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective Courses</th>
<th>18 units</th>
</tr>
</thead>
</table>

Elective courses are to be chosen from those courses listed for the School of Music in the current course catalog. Performance electives are encouraged. (An audition is required for all School of Music performance ensembles.)

Minimum units required: 67

### Minor in Music Technology

This sequence is for candidates who majors from any discipline in the university who have some background in music and would like to know more about music technology.

**Note:** Students in the School of Music have slightly different requirements for the Minor in Music Technology. See School of Music (p. 163).

**Admission Requirements**

The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

<table>
<thead>
<tr>
<th>Prerequisite Course</th>
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Beginning Piano is required of students who do not pass a piano proficiency test.

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</table>

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<thead>
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<th>18 units</th>
</tr>
</thead>
</table>

Elective courses are to be chosen from those courses listed for the School of Music in the current course catalog. Performance electives are encouraged. (An audition is required for all School of Music performance ensembles.)

Minimum units required: 67

### Minor in Music Theory

This sequence is for candidates who are majors from any discipline in the university who have some background in music and would like to know more about music theory.

<table>
<thead>
<tr>
<th>Prerequisite Course</th>
<th>0-3 units</th>
</tr>
</thead>
</table>

Beginning Piano is required of students who do not pass a piano proficiency test.

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<tr>
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</tr>
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Basic Harmony I and/or Basic Solfege I are required of students who do not qualify for entrance into Harmony I and/or Solfege I, based on their scores on the theory and solfege placement tests.

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<tr>
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<th>24 units</th>
</tr>
</thead>
<tbody>
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<td>Elective Studio</td>
</tr>
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<td>57-xxx</td>
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</table>

<table>
<thead>
<tr>
<th>Elective Courses</th>
<th>18 units</th>
</tr>
</thead>
</table>

Elective courses are to be chosen from those courses listed for the School of Music in the current course catalog. Performance electives are encouraged. (An audition is required for all School of Music performance ensembles.)

Minimum units required: 67

### Music Technology/Sound Courses (choose 3)

Choose three courses. One of the three courses must be either Introduction to Computer Music or Electronic and Computer Music. (Note that 15-112 is a prerequisite for 15-322; 57-101 or 57-171 is a prerequisite for 57-347.)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-322</td>
<td>Introduction to Computer Music</td>
<td>9</td>
</tr>
<tr>
<td>15-323</td>
<td>Computer Music Systems and Information Processing</td>
<td>9</td>
</tr>
<tr>
<td>33-214</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>54-509</td>
<td>Advanced System Design</td>
<td>9</td>
</tr>
<tr>
<td>54-666</td>
<td>Production Audio</td>
<td>6</td>
</tr>
<tr>
<td>57-347</td>
<td>Electronic and Computer Music</td>
<td>6</td>
</tr>
</tbody>
</table>
Note: Students in the School of Music have slightly different requirements for the Minor in Music Theory. See School of Music [https://coursecatalog-new.web.cmu.edu/collegeoffinearts/schoolofmusic/#minorinmusictechnologyforstudentsintheschoolofmusic](https://coursecatalog-new.web.cmu.edu/collegeoffinearts/schoolofmusic/#minorinmusictechnologyforstudentsintheschoolofmusic).

Admission Requirements

The student must apply to enter the program in the office of the Directory of Student Services (CFA 108).

Prerequisite Course  
0-3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-294  Beginning Piano Test  0
57-329  Beginning Piano for Minors  3

Required Music Courses  25 units

57-152  Harmony I  9
57-161  Eurythmics I  3
57-173  Survey of Western Music History  9
57-181  Solfege I  3
57-188  Repertoire and Listening for Musicians  1

Required Theory Courses  21 units

57-151  Counterpoint in Theory and Application  6
57-153  Harmony II  9
57-408  Form and Analysis  6

Advanced Theory Course (choose 1)  6 units

See theory courses on the Music Support Courses Two-Year Rotation list. It is available on the insideMusic website: http://music.cfa.cmu.edu/. Click on Music Support Course Two-Year Rotation. A graduate course may be taken with the permission of the instructor.

Elective Courses  18 units

Elective courses are to be chosen from those courses listed for the School of Music in the current course catalog.

Minimum units required: 70

Minors under CFA Dean’s Office

Minor in Photography

The Photography Minor exposes students to the breadth of photography offering experiences in traditional photography (i.e., film exposure and silver printing) to digital shooting and output. The student who takes the Photography Minor will become familiar with photography’s craft, its history and significant practitioners, and develop his/her own distinct engagement with the medium.

Students may apply for the Photography Minor after they have taken a CFA or Pittsburgh Filmmakers’ beginning photography course. Freshmen should not apply for the minor. Students in four-year undergraduate programs may apply in their sophomore or junior year. Students in five-year undergraduate programs, such as Architecture, may apply in their second, third, or fourth year. Applications are accepted in both the fall and spring semesters. Students will be admitted to the minor based on their aptitude, appropriate level of photography skills, and space availability within the program. Once admitted, students will be assigned a faculty advisor who will help them determine a sequence of courses that best fits their needs and interests.

Application Requirements

The application process for the Photography Minor requires submission of: a completed application form signed by the home department advisor, a personal statement, and a portfolio of photographs. Contact the CFA Photography Administrator, Jamie Gruzska, MM B18, for further information and an application form.

Photography Required Courses (3)  minimum 27 units

62-165  Mutable Landscape: Drawing and the Digital Photographic Image  10
62-205  Documentary Photography  9
62-245  Portrait Photography  10
62-265  Alternative Photo Processes  10
62-325  View Camera  10
62-326  Photographic Narrative  9
62-329  Modern Ruin  10
62-337  Studio Lighting  10
62-375  Large Format Photography: The Antiquarian Avant-Garde  10

Photo History Required Course (1)  9 units

62-371  Photography, The First 100 Years **  9
or 62-360  Photographers and Photography Since World War II

History, Theory, or Criticism of the Visual Arts Elective (1)  9 units

Choose one (1) additional History, Theory or Criticism of the Arts course in consultation with the photo advisor. A second Photo History course (62-360 or 62-371) can be used for this requirement.

* prerequisite for photo courses other than history, theory, and/or criticism course

** or course approved by the photography advisor

Minimum units required: 54
**School of Architecture**

Stephen R. Lee, AIA, LEED AP, Head
Office: CFA 201
http://www.cmur.edu/architecture

The mission of the School of Architecture is to educate outstanding professionals with design creativity, social responsibility, global environmental vision, historical perspective, and technical excellence. Our comprehensive curriculum and the accomplishments of our expert faculty fully reflect this dedication.

**Bachelor of Architecture Program**

The Bachelor of Architecture Program is five years in length and is fully accredited by the National Architectural Accrediting Board (NAAB)*. The program provides preparation for a required architectural internship, then entry into the practice of architecture. The curriculum consists of courses centered around an Integrated Design Studio Sequence with foci in seven areas: Integrated Architectural Design Studios, Fundamental University Courses and Electives, History, Drawing and Digital Media, Building Technology, Environmental Technology, and Professional Practice. All required courses in the first two years must be taken and passed before a student may enter the third year. A minimum of 477 units is required for graduation in the undergraduate program (483 with thesis).

In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.

Doctor of Architecture and Master of Architecture degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree that, when earned sequential, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

Carnegie Mellon University School of Architecture offers the following NAAB-accredited degree program:

Bachelor of Architecture (483 units)

*Next accreditation visit for this program is 2018.

**Curriculum**

**First Year**

48-100 Architecture Design Studio: Foundation I 12
48-025 First Year Seminar: Architecture Edition 3
48-116 Building Physics 9
48-120 Introduction to Digital Media I 6
48-130 Architectural Drawing I: A Tactile Foundation 9
79-104 Global Histories 9
48-105 Architecture Design Studio: Foundation II 12
48-026 First Year Seminar: Architecture Edition II 3
48-125 Introduction to Digital Media II 6
48-135 Architectural Drawing II: Appearance 9
48-240 Historical Survey of World Architecture and Urbanism I 9
62-175 Descriptive Geometry 6
99-101 Computing @ Carnegie Mellon 3

**Second Year**

48-200 Architecture Design Studio: Composition 18
48-210 Statics 9
48-241 Survey of Architectural History II 9
xx-xxx University Elective (I) 9
48-205 Architecture Design Studio: Materials 18
48-215 Materials and Assembly 9
48-217 Structures 9
76-101 Interpretation and Argument 9

**Third Year**

48-300 Architecture Design Studio: Environment 18
48-315 Environmental I: Climate & Energy 9
48-xxx Architectural History III 9
xx-xxx University Elective (2) 9
48-305 Architecture Design Studio: Advanced Construction 18
48-351 Human Factors in Architecture 9
48-551 Ethics and Decision Making in Architecture 9
xx-xxx University Elective (3) 9

**Fourth Year**

48-400 Architecture Design Studio: Occupancy 18
48-412 Environment II: Mechanical Systems 9
48-550 Issues of Practice 9
48-xxx School Elective (1) 9
48-405 Architecture Design Studio: Systems Integration 18
48-xxx School Elective (2) 9
xx-xxx University Elective (4) 9
xx-xxx University Elective (5) 9
xx-xxx University Elective (6) 9

**Fifth Year**

48-500 Architecture Design Studio: The Urban Laboratory 18
48-452 Real Estate Design and Development 6
48-453 Urban Design Methods 6
48-497 Thesis I 9
xx-xxx University Elective (7) 9
xx-xxx University Elective (8) 9
48-50x Architecture Design Studio: Thesis/Studio X 18
xx-xxx University Elective (9) 9
xx-xxx University Elective (10) 9
xx-xxx University Elective (11) 9
xx-xxx University Elective (12) 9

Total number of units required: 483

**Fundamental University Courses** (4 lecture courses)

A significant set of university courses in mathematics, physical sciences, social sciences, writing, and history are prerequisite to the School’s own offerings. Beyond the preparation in fundamentals that these courses provide, this early emphasis upon core university course work allows for transfer to other departments within the College and University following the first several semesters of the student’s studies.

62-175 Descriptive Geometry 6
76-101 Interpretation and Argument 9
79-104 Global Histories 9
99-10x Computing @ Carnegie Mellon 3

**Integrated Design Studios** (10 Studios)

Architectural design studios compose the core of the undergraduate curriculum. The ten studios are organized around a sequence of semester topics that are the focus of the design projects. In sequence, these topics are: foundations, composition, materials, site construction, occupancy, systems integration, and urban design. Studio X is intended to allow for study abroad, thesis, or interdisciplinary studies. As an integrated sequence, requisite courses work in conjunction with specific studios to provide students with the necessary knowledge base to successfully resolve their design projects. Design studios are taught using a team approach, with a common lecture series and a set of related exercises for each studio level. Faculty members are practicing architects, scholars, as well as academic researchers bringing a diverse set of perspectives to the studio environment. Studio spaces are provided to all students located in Margaret Morrison Hall and College of Fine Arts Building. Studios provide a faculty to student ratio of 1:12.

48-100 Architecture Design Studio: Foundation I 12
48-105 Architecture Design Studio: Foundation II 12
48-200 Architecture Design Studio: Composition 18
48-205 Architecture Design Studio: Materials 18
48-300 Architecture Design Studio: Environment 18
48-305 Architecture Design Studio: Advanced Construction 18
48-400 Architecture Design Studio: Occupancy 18
Three core courses in architectural history are required for the Bachelor of Architecture degree. Students take the two-semester sequence of "History of World Architecture" during the second semester of the first year and the first semester of the Second Year. This two-semester survey focuses on major architectural examples and movements across time and space, including both western and non-western architectural and urban practices.

One additional elective course on the history of architecture is required to complete the "Core 3" of architectural history. The multiple architectural history electives feature tightly-focused topics, small class sizes, and are intended to provide students with advanced research and writing skills. All "Core 3" courses must be taken within the School of Architecture and must have been designated as satisfying the core requirements.

Students are encouraged to take additional architectural histories beyond the basic "Core 3" sequence. A minor in Architectural history is available to students completing four additional, approved, nine-unit architectural history courses beyond the "Core 3".

Drawing and Media (4 courses)

Drawing and modeling both by hand and with the computer are core skills for developing powers of observation, the ability to think in three dimensions, and are fundamental in communicating architectural ideas. Computational skills, including the use of programs specializing in digital representation, in combination with traditional skills of representation are stressed in courses throughout the curriculum.

Drawing, media representation, and model making are primary topics of both first year studios and are associated with five other specific courses: Introduction to Digital Media I and II, Architectural Drawing I and II in the first year. Thereafter students may elect to take further drawing and media courses during years two, three, four and five in fulfillment of the school elective requirements.

Technology: Building, Materials, and Structures (3 courses)

The School sees technical knowledge as design knowledge and places major emphasis on understanding the state-of-the-art and major innovations in building structure, enclosure, mechanical, lighting, and interior systems. The goal of the Structures and Building sequence is to offer a rigorous introduction to science fundamentals, to provide a systematic and comprehensive introduction into the major fields of building science and technology, and to provide a solid technical foundation both for architectural design studios and for more advanced subsequent science and technology electives. Courses build on one upon the other and provide technical knowledge for application in the design studio as well as providing foundations for more in-depth study and minors in associated fields.

Technology: Environment (3 courses)

The School sets environmental education as one of its highest priorities. The goal of this sequence is to provide a thorough foundation of technical knowledge coupled with a creative design inquiry, which allows students to effectively address serious environmental challenges. The courses address issues raised by concerns over the ecological responsiveness of buildings to context, energy effectiveness, and healthy building design for global environmental sustainability while considering the opportunities of human differences related to the psychology of the individual, the sociology of groups, ergonomics, ADA codes & standards and indoor environmental quality including acoustic, visual, air and thermal quality of spaces designed for human habitation.

Critical Practice (7 courses)

Architecture is a multifaceted field of practice, existing within dynamic social, organizational, economic, professional, and cognitive contexts. The goal of this sequence is to educate design professionals with expertise in: programming and diverse design decision making processes, multi-disciplinary team design processes, methods of professional practice in urban design and architecture, management and documentation, facilities management including field diagnostics and post occupancy evaluation, real property management and overriding questions of ethics in practice.

General Studies and Electives (15 Courses/135 units)

A professional degree program must include general studies in the arts, humanities, and sciences, either as an admission requirement or as part of the curriculum. It must demonstrate that students have the prerequisite general studies to undertake professional studies. The curriculum leading to the architecture degree must include at least 135 units outside of architectural studies either as a minor or as electives with other than architectural content. A professional degree program must allow students to pursue their special interests. The curriculum must be flexible enough to allow students to complete minors or develop areas of concentration, inside or outside the program.

Minors in Other Disciplines

Minors may be earned in many of the Departments or Schools on campus. Generally, a student must take six courses within a specific department or minor. Students interested in minors must contact the school or department of interest to determine specific requirements or prerequisites. Since students of architecture are required to take fifteen electives (135 units), students can easily complete a minor without adding additional coursework to their curriculum.

Minors in Architecture

Undergraduate students in architecture can also qualify to earn three minors within the subject of architecture. These are the Minor in Architectural History, the Minor in Building Science, and the minor in Architectural Representation and Visualization. The Minor in Architectural History is intended for those candidates who want particular depth in this area. It is earned by applying all three school electives and four university electives to courses in architectural history. The Minor in Building Science is intended for those degree candidates seeking in deep knowledge in the area of architectural science and for those who are interested in gaining advanced placement in the M.S. programs offered by the School in the areas of Building Performance and Sustainable Design. The Minor in Architectural Representation and Visualization is for candidates who intend to develop particular skills in architectural representation.

Graduate Degree Programs

Carnegie Mellon University is recognized for outstanding contributions to science, technology, management, policy, and the fine arts. The School of Architecture builds on a tradition of interdisciplinary study.

Our faculty's diverse set of backgrounds and commitment to professional practice and scholarly research make us a rich resource for students and professionals, in the U.S. and abroad.

Our graduates hold positions in innovative design practices, research organizations, federal and municipal governments, the building and manufacturing industries, and at leading universities both in the U.S. and abroad.

Our programs reflect a commitment to excellence. Students with motivation and ability receive an outstanding educational opportunity at Carnegie Mellon University’s School of Architecture.

The School of Architecture offers seven (7) post-professional Master, and three (3) PhD degrees in the following areas of study:

Master of Science in Architecture

The Master of Science in Architecture (MSA) is a post-professional, research-based degree program intended primarily for practitioners in the building industry who are interested in broadening their knowledge base and skill set for use in professional practice. This program is structured on a 9-month (2 semester) curriculum, allowing those already established in the field to take a leave of absence and return with relatively little discontinuity to their careers.

The MSA program allows each student the freedom to customize his or her own curriculum. While this program is ideal for students seeking to enhance...
an existing skill set, it can also act as a testing ground where students are able to explore new and varied areas of academic study. Whether one chooses to delve deeply into a focused area of research or acquire a broad overview, students are encouraged to draw from resources both within the School of Architecture and throughout the University.

Master of Science in Computational Design and Doctor of Philosophy in Computational Design
One of the first and best-known Computational Design programs in the US, our legacy continues today. Under the direction of dedicated faculty and in collaboration with other departments in the University, e.g., School of Computer Sciences and the Department of Civil & Environmental Engineering), our visionary students continue to push for innovation and evolution of the state-of-the art in design technology.

Master of Science in Building Performance and Diagnostics and Doctor of Philosophy in Building Performance and Diagnostics
Building Performance & Diagnostics deals with the comprehensive integration of building design and advanced technology, as a means of producing high performance architecture. Led by the Ctr for Building Performance & Diagnostics (CBPD) and housed within the Robert L. Preger Intelligent Workplace (http://www.cmu.edu/greenpractices/greenign-the-campus/green-buildings/intelligent-workplace.html), students have the opportunity to gain both diversity and depth of knowledge from world-renowned an experienced faculty.

Master of Urban Design
Building on our legacy of Urban Design, and in partnership with the Remaking Cities Institute (RCI) (http://www.cmu.edu/rci), this 12-month, Studio-based Master of Urban Design program emphasizes environmental, economic, social and cultural issues affecting the contemporary metropolis, while providing a comprehensive foundation in design, theory, history, policy, management and technical skill.

Master of Science of Tangible Interaction Design
The Master of Tangible Interaction Design (tMD) is truly an interdisciplinary program that integrates computational intelligence and the physical world. MTID students make interaction tangible by building and programming working prototypes. Housed in the Computation Design (CoDe) Lab (http://code.arc.cmu.edu), and leveraging our state-of-the-art Digital Fabrication (dfab) Lab (http://www.cmu-dfab.com), the program cultivates experimentation and collaboration in an intimate studio setting.

Master of Science in Sustainable Design
At the forefront of research in sustainable design and technology for over 35 years, Carnegie Mellon’s School of Architecture is recognized internationally for its large core of dedicated faculty, providing a solid foundation from which students can learn how to positively and sustainably affect the future of the built environment. This is a post-professional degree program that integrates Design and Technology to provide a comprehensive knowledge base for professional practice.

Master of Science in Architecture-Engineering Construction Management and Doctor of Philosophy in Architecture-Engineering Construction Management
A joint effort between the School of Architecture and the Department of Civil & Environmental Engineering, the Architecture-Engineering-Construction Management (AECM) programs prepare building delivery professionals for careers in capital project delivery. Graduates are educated to become effective decision makers who can positively impact economic, environmental, and ethical aspects of the built environment through professional management strategies. AECM programs deal with the entire life-cycle of capital projects, from pre-design, to design, construction, commissioning, operation, and maintenance stages. They focus on the integration of design and technology, in particular, advanced information systems, as a means of improving building performance, and eliminating negative environmental impact.

Advanced Standing in Master Degree Programs
The School of Architecture offers a unique opportunity to undergraduate students who wish to pursue a Masters degree in an architecture-related field through the Accelerated Masters Program (AMP). Undergraduate students may apply to the AMP in their 4th year of their architecture education, and if accepted, can apply units earned in their 5th year of their undergraduate architecture degree to their graduate degree. This allows students to graduate with a Masters degree in an accelerated period of time.

Student Advising
At the end of every semester, the faculty reviews each student’s progress in all courses. Reviews during the first year are intended to determine a student’s capabilities in relation to the study of architecture at Carnegie Mellon University, and the School works with each student to ensure placement within the university if a change is desired. Subsequent reviews monitor and ensure continued progress in all sequences of the program.

Students are urged to meet with the Senior Academic Advisor to review their academic progress and plans before each semester. Such meetings are important to take full advantage of elective possibilities within the curriculum, general progress toward graduation, and study abroad opportunities. Students should also check their progress using the online academic audit in the Student Information Online (SIO).

Scholarships and Awards
The School of Architecture provides a number of scholarship and traveling fellowship opportunities to outstanding students. These opportunities include: Stewart L. Brown Memorial Scholarship, Gindroz Prize, Ferguson Jacobs Prize in Architecture, Myres & Lubetz Internship Fund, John P. Junge Memorial Scholarship, The Richard M. Gensert Memorial Scholarship, and the Cornerstones Scholarship Award.

Students who are eligible to participate in the School’s Fourth-Year Design Awards Competition have the opportunity to compete for the following five prizes: John Knox Shear Memorial Traveling Scholarship, Louis F. Valenta Traveling Scholarship Fund, Luther Lashmit Award, Burdett Assistantship, and the Lewis J. Altenhof Memorial Scholarship.

Study Away Program
The School of Architecture has an officially recognized departmental exchange program for students to study away at TU Braunschweig. Students in the School of Architecture have the unique opportunity to study at the Carnegie Mellon University campus in Qatar with our faculty. Students accepted to study at Educational City in Doha are able to complete their third or fourth year, spring studio. There are additional opportunities to study abroad through University Direct Exchanges, University Sponsored programs, and external programs.

Students are also welcome to seek out the many other study away opportunities where course work is equivalent to studies at CMU to a maximum of 45 transfer units per semester. To receive credit for courses taken away, the student must have a C or better (not C-) in the course and have an official translated transcript sent to the School of Architecture. Studio work conducted abroad must be presented to the School Head and Studio Coordinator for approval.

Students should make the decision to study away by the fall of their second year, so they can plan their courses accordingly. Students are allowed to take courses away for which they receive studio credit only for those students at approved year-long direct exchange programs. To qualify for study away, a student must have completed the second-year of their program, have a minimum overall GPA of a 3.00 (or 2.75 for SoArch summer study abroad) and be in good academic standing.

Summer Courses
Students can receive credit for passing comparable courses at other institutions with advanced approval from the School. A Transfer Credit Evaluation form must be completed prior to enrollment at the other institution for a course to be considered for transfer.

Faculty
OMER AKIN, Professor – PhD, Carnegie Mellon University; Carnegie Mellon, 1973–.
MARYLOU ARSCOTT, Studio Professor – BArch, Architectural Association; Carnegie Mellon, 2007–.
MARTIN AURAND, Principal Architecture Librarian/Archivist – MLIS, University of Pittsburgh; Carnegie Mellon, 1987–.
AZIZAN AZIZ, Senior Researcher, CBPD – MS Building Performance & Diagnostics, Carnegie Mellon University; Carnegie Mellon, 1997–.
KELLIE BROOKS, Adjunct Assistant Professor – MArch, University of Oregon; Carnegie Mellon, 2009–.
LEE CALISTI, Adjunct Assistant Professor – BArch, Kent State University; Carnegie Mellon, 2002–.
DONALD K. CARTER, Director, Remaking Cities Institute – BArch, Carnegie Mellon University; Carnegie Mellon, 2009–.

DALE CLIFFORD, Assistant Professor – MArch, Massachusetts Institute of Technology; Carnegie Mellon, 2009–.

DOUG COOPER, Andrew Mellon Professor – BArch, Carnegie Mellon University; Carnegie Mellon, 1976–.

FREDDIE CROCE, Adjunct Assistant Professor – BArch, The New School of Architecture; Carnegie Mellon, 2008–.

GERARD DAMIANI, Associate Professor – BArch, Syracuse University; Carnegie Mellon, 1996–.

STEFANI DANES, Adjunct Professor – MArch, Yale University; Carnegie Mellon, 1986-2001, 2009–.

JEFFREY DAVIS, Adjunct Professor – BS Architecture, University of Illinois, Urbana-Champaign; Carnegie Mellon, 1996–.

JENNIFER GALLAGHER, Adjunct Assistant Professor – BArch, Notre Dame; Carnegie Mellon, 2008–.

NICHOLAS LIADIS, Adjunct Assistant Professor – MArch, University of Detroit; Carnegie Mellon, 2010–.

EVE PICKER, Adjunct Associate Professor – MArch and Urban Design, Columbia; Carnegie Mellon, 2010–.

RAMI EL SAMAHY, Assistant Teaching Professor – MArch, Harvard University; Carnegie Mellon, 2006–.

JOHN EBERHARD, Professor Emeritus – M.S., Industrial Management, Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

JEREMY FICCA, Associate Professor, Director dFab Lab – MArch, Harvard University; Carnegie Mellon, 2007–.

JOHN FOLAN, T. David Fitz-Gibbon Associate Professor – MArch, University of Pennsylvania; Carnegie Mellon, 2008–.

JONATHAN GOLLI, Adjunct Assistant Professor – MArch, University of Toronto; Carnegie Mellon, 2007–.

MARK GROSS, Professor, Associate Head, Director CoDE Lab – PhD, Massachusetts Institute of Technology; Carnegie Mellon, 2004–.

KAI GUTSCHOW, Associate Professor – PhD, Columbia University; Carnegie Mellon, 1998–.

VOLKER HARTKOPF, Professor, Director CBPD – PhD, University of Stuttgart; Carnegie Mellon, 1972–.

DELBERT HIGHLANDS, Professor Emeritus – MArch, Carnegie Mellon University; Carnegie Mellon, 1985–.

KELLY HUTZELL, Associate Teaching Professor – MS Architecture and Urban Design, Columbia University; Carnegie Mellon, 2005–.

JONATHAN KLINE, Adjunct Associate Professor – MFA, Penn State University; Carnegie Mellon, 2002–.

RAMESH KRISHNAMURTI, Professor – PhD, University of Waterloo; Carnegie Mellon, 1989–.

KRISTEN KURLAND, Teaching Professor – BArch, University of Pittsburgh; Carnegie Mellon, 1996–.

KHEE POH LAM, Professor – PhD, Carnegie Mellon University; Carnegie Mellon, 2003–.

STEPHEN LEE, Professor and Head – MArch, Carnegie Mellon University; Carnegie Mellon, 1981–.

DAVID LEWIS, Teaching Professor Emeritus – MArch, Leeds College of Architecture; Carnegie Mellon, 1982–.

CINDY LIMAURU, Professor, Drama – MFA in Lighting Design, Florida State University; Carnegie Mellon, 1987–.

VIVIAN LOFTNESS, University Professor – MArch, Massachusetts Institute of Technology; Carnegie Mellon, 1981–.

ARTHUR LUBETZ, Adjunct Professor – BArch, Carnegie Mellon University; Carnegie Mellon, 1988–.

MICK MCNUTT, Adjunct Assistant Professor – MArch, Syracuse University; Carnegie Mellon, 2007–.

CHRISTINE MONDOR, Adjunct Associate Professor – BArch, Carnegie Mellon University; Carnegie Mellon, 1999–.

IRVING OPPENHEIM, Professor – PhD, Cambridge; Carnegie Mellon, 1972–.

MATTHEW PLECITY, Adjunct Assistant Professor – MArch, Virginia Tech; Carnegie Mellon, 2006–.

STEPHEN QUICK, Adjunct Professor – MArch, Cornell University; Carnegie Mellon, 2010–.

CHARLES ROSENBLUM, Assistant Teaching Professor – PhD, University of Virginia; Carnegie Mellon, 2000–.

DIANE SHAW, Associate Professor – PhD, University of California - Berkeley; Carnegie Mellon, 1996–.

SCOTT SMITH, Director, Shop – MFA, Cranbrook; Carnegie Mellon, 1984–.

KENT SUHRBIER, Adjunct Associate Professor – BArch, Carnegie Mellon University; Carnegie Mellon, 2000–.

FRANCESCA TORELLO, Adjunct Assistant Professor – PhD, Politecnico Torino; Carnegie Mellon, 2007–.

SPIKE WOLFF, Adjunct Assistant Professor – MArch, SCI-Arc; Carnegie Mellon, 2003–.
School of Art

John Carson, Head
Office: College of Fine Arts 300
http://www.cmu.edu/300

The university-based undergraduate program offered by the School of Art is designed to develop individuals capable of working as artists in a complex, rapidly changing global culture. The program incorporates an expansive approach to art and acknowledges that "working as artists" leads toward a wide variety of pursuits.

Admission to the undergraduate program is highly competitive. Students must show promise of excellence in both academic and artistic performance. Evidence of creative leadership is a plus.

The art faculty, all practicing artists or scholars, provide an intense, professional learning environment in which students develop close ties with their instructors and each other.

Art students are encouraged to take full advantage of the university environment through exposure to faculty and students in other departments in the College of Fine Arts and throughout the University. They are also encouraged to participate in the numerous cultural opportunities on campus and in the larger Pittsburgh community.

The School of Art maintains a variety of studio and workshop accommodations to make possible its wide range of media offerings. It occupies the top two floors of the College of Fine Arts building, as well as a significant portion of Doherty Hall. Numerous exhibition venues inform or present student work including the Ellis Gallery, The Miller Gallery, and the Frame Gallery, which is managed entirely by students.

The progressive curriculum requires that students attain high levels of knowledge, skill and commitment. The four-year undergraduate program offers one general Bachelor of Fine Arts (B.F.A.) in Art.

Using five categories of courses, the curriculum presents art-making in a unique manner which respects tradition and encourages innovation. The course categories are:

I. Concept Studios
II. Media Studios
III. Advanced Studios
IV. Academic Art Courses
V. University Academic Courses

Evidence of creative leadership is a plus.

Admission to the undergraduate program is highly competitive. Students must show promise of excellence in both academic and artistic performance. After Freshman Year

The student is required to take the following three courses:

Computing @ Carnegie Mellon (99-101), Global Histories (79-104), and Interpretation and Argument (76-101).

After Freshman Year

The student must then take at least three additional courses from ONE of the academic areas/options listed above.

Finally, the student must take two additional, but unspecified, academic electives.

In selecting courses for the university academic component of the curriculum, students are encouraged to complete a cluster of courses that appeals to and develops their interests as emerging artists. In the process of taking their university electives, students can often simultaneously earn a minor.

Bachelor of Fine Arts (B.F.A.) Curriculum

Below is the recommended distribution of courses in the four-year B.F.A. curriculum. After the freshman year, students may begin to choose university electives. After the first semester of the sophomore year, students have more options regarding the sequencing and selection of their coursework.

First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-101 Concept Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-120-130 3-D Media Studio I and 3-D Media Studio I Mini 1 and Mini 2 must be in different media.</td>
<td>20</td>
</tr>
<tr>
<td>60-150 20 Media Studio: Drawing</td>
<td>10</td>
</tr>
<tr>
<td>60-104 Contemporary Issues Forum</td>
<td>6</td>
</tr>
</tbody>
</table>
Second Year

Fall Units
60-201 Concept Studio II 10
60-210 Electronic Media Studio II 10
60-250 2D Media Studio: Painting 10
60-251 2D Media Studio: Print Media 10
60-205 Modern Visual Culture 1789-1945 9
xx-xxx Academic Elective 9

Spring Units
60-202 Concept Studio III 10
60-4xx Advanced Studio Elective 10
60-4xx Advanced Studio Elective 10
60-206 Contemporary Visual Culture from 1945 to the Present 9
xx-xxx Academic Elective 9

Third Year

Fall Units
60-4xx Contextual Practice Elective 10
60-4xx Advanced Studio Elective 10
60-4xx Advanced Studio Elective 10
60-3xx Academic Art Elective 9
xx-xxx Academic Elective 9

Spring Units
60-4xx Advanced Studio Elective 10
60-4xx Advanced Studio Elective 10
60-4xx Advanced Studio Elective 10
xx-xxx Academic Elective 9

Fourth Year

Fall Units
60-401 Senior Studio 20
60-4xx Advanced Studio Elective 10
xx-xxx Academic Elective 9

Spring Units
60-402 Senior Studio 20
60-4xx Advanced Studio Elective 10
xx-xxx Academic Elective 9

Total Units for the B.F.A. Art Degree 384

Sophomore and Senior Year Reviews

Students give an overview of their work twice in their four-year course of study. At the end of the sophomore year, students undergo a faculty review of their work to date in the program. A successful review is required for advancement to the junior year.

The senior review affords graduating students the opportunity to review, analyze and summarize their work and to engage a faculty committee in discussion about issues that face someone preparing to enter a career in art.

Art Majors Minoring or Double Majoring in Another Department

About a third of current B.F.A. Art students pursue a minor or a second major. If students are contemplating this option, they must discuss their plans with academic advisors from the minor or second major department as well as with the School of Art academic advisor.

Study Abroad

Art students are encouraged to spend either a semester of their junior year, or a summer before or after their junior year, in one of many available international programs. These programs include exchange programs sponsored by the School of Art in which a student’s financial aid package remains in effect, and programs sponsored by other institutions. International exchange programs currently active include the following:

- China: Chinese University of Hong Kong, Shatin, Hong Kong
- France: Ecole nationale superieure des Beaux-Arts, Paris
- Germany: Universitat der Kunste Berlin, Berlin
- Ireland: Burren College of Art and Design, Burren
- Israel: Bezalel Academy, Jerusalem
- Japan: Tokyo Polytechnic University, Tokyo
- Korea: The Korean National University of the Arts, Seoul
- New Zealand: Auckland Institute of Technology, Auckland
- Programs with other Pittsburgh Institutions

Art students are eligible to take courses at the nearby University of Pittsburgh’s History of Art and Architecture Department, at Pittsburgh Filmmakers, and at the Pittsburgh Glass Center. Established agreements with these institutions and other Pittsburgh colleges, universities or centers offer cross-registration opportunities at no additional expense to the student.

BXA Intercollege Degree Programs

Bachelor of Humanities and Arts (BHA) Bachelor of Science and Arts (BSA) Bachelor of Computer Science and Arts (BCSA)

Carnegie Mellon University offers a degree program that combines an Art Focus (11 courses for BHA and BSA, 12 courses for BCSA) with a focus in the College of Humanities and Social Sciences, the Mellon College of Science, or the School of Computer Science. The Assistant Head of the School advises BHA, BSA, and BCSA majors in selecting courses in the Art Focus. A description of these three programs (collectively known as BXA), and a list of requirements and electives, can be found in the in the BHA, BSA, and BCSA sections of this catalog.

Art Minors

Students from other colleges and departments are eligible to pursue a minor in art. A minor requires six courses in the School of Art, selected from a list of requirements and electives as described in the CFA minors section of this catalog.

Master of Fine Arts (M.F.A.) Degree

The School of Art offers a three-year program leading to a Master of Fine Arts in Art. This is a unique program designed to connect art-making to the university at large, and to Pittsburgh communities and organizations. Information about this program is available at the School of Art website: http://www.cmu.edu/art.

Master of Arts Management (M.A.M.) Degree

The College of Fine Arts and the Heinz College School of Public Policy and Management co-sponsor a Master of Arts Management degree. Students admitted to the M.A.M. degree program in their junior year may complete both a Bachelor of Fine Arts degree and a Master of Arts Management degree in five years. Students interested in this graduate degree should consult with advisors early in their undergraduate program.

Pre-College Programs

The School of Art maintains two pre-college programs: a Saturday program during the academic year and a six-week program during the summer. These programs are designed to prepare the college-bound high school student for college level work in art. Information on these programs may be obtained by contacting the School of Art.

Full-Time Tenure Track Faculty

KIM BECK, Associate Professor of Art – M.F.A., Rhode Island School of Design; Carnegie Mellon, 2004–.

JON BECKLEY, Professor of Art – M.F.A., Ohio University; Carnegie Mellon, 1979–.

PATRICIA BELLAN-GILLEN, Dorothy L. Stubnitz Professor of Art – M.F.A., Carnegie Mellon University; Carnegie Mellon, 1986–.

BOB BINGHAM, Professor of Art – M.F.A., University of California, Davis; Carnegie Mellon, 1993–.
LOWRY BURGESS, Professor of Art – Post-Graduate Degree, Pennsylvania Academy of Fine Arts/University of Pennsylvania; Carnegie Mellon, 1989–.

JOHN CARSON, Regina and Marlin Miller Professor of Art and Head of the School of Art – M.F.A., California Institute of the Arts; Carnegie Mellon, 2006–.

JAMES DUESING, Professor of Art – M.F.A., University of Cincinnati; Carnegie Mellon, 1997–.

ANDREW JOHNSON, Associate Professor of Art – M.F.A., Carnegie Mellon University; Carnegie Mellon, 2004–.

ELAINE A. KING, Professor of Art History and Theory – Ph.D., Northwestern University; Carnegie Mellon, 1981–.

CAROL KUMATA, Professor of Art – M.F.A., University of Wisconsin, Madison; Carnegie Mellon, 1979–.

GOLAN LEVIN, Associate Professor of Art – M.S., Massachusetts Institute of Technology; Carnegie Mellon, 2004–.

JOSEPH MANNINO, Professor of Art – M.F.A., University of Southern Illinois; Carnegie Mellon, 1986–.

CLAYTON MERRILL, Associate Professor of Art – M.F.A., Yale University; Carnegie Mellon, 1998–.

ALI MOMENI, Assistant Professor of Art – Ph.D., University of California at Berkeley; Carnegie Mellon, 2012–.

AYANAH MOOR, Associate Professor of Art – M.F.A., Tyler School of Art; Carnegie Mellon, 1999–.

RICHARD PELL, Assistant Professor of Art – M.F.A., Rensselaer Polytechnic Institute; Carnegie Mellon, 2008–.

MARTIN PREKOP, Professor of Art – M.F.A., Rhode Island School of Design; Carnegie Mellon, 1993–.

MELISSA RAGONA, Associate Professor of Visual Culture and Critical Theory – Ph.D., State University of New York at Buffalo; Carnegie Mellon, 2003–.

HILARY ROBINSON, Professor of Art Theory and Criticism – Ph.D., University of Leeds; Carnegie Mellon, 2005–.

CHARLES ROSENBLUM, Assistant Teaching Professor of Art and Architecture University of Virginia; .

JON RUBIN, Associate Professor of Art – M.F.A., California College of Arts and Crafts; Carnegie Mellon, 2006–.

SUZIE SILVER, Associate Professor of Art – M.F.A., The School of the Art Institute of Chicago; Carnegie Mellon, 1999–.

SUSANNE SLAVICK, Andrew W. Mellon Professor of Art – M.F.A., Tyler School of Art; Carnegie Mellon, 1984–.

MARY WEIDNER, Professor of Art – M.F.A., Washington University; Carnegie Mellon, 1976–.

Visiting Faculty
PAOLO PEDERCINI, Visiting Assistant Professor of Art – M.F.A., Rensselaer Polytechnic Institute; Carnegie Mellon, 2009–.

Full-time Joint Appointments
CHARLEE BRODSKY, Associate Professor of Art and Photography – M.F.A., Yale University; Carnegie Mellon, 1978–.

ROGER DANNENBERG, Senior Research Computer Scientist and Artist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982–.

JUDITH SCHACHTER, Professor of Anthropology, History, and Art – Ph.D., University of Minnesota; Carnegie Mellon, 1984–.

Adjunct Courtesy Appointments
ROBERT BECKMAN, Adjunct Assistant Professor of Art – M.F.A., Kent State University; Carnegie Mellon, 2001–.

SARAH ELDREDGE, Adjunct Assistant Professor of Art.

JAMIE GRUZSKA, Special Faculty and CFA Photography Administrator.

PATRICIA MAURIDES, Adjunct Assistant Professor of Art – M.F.A., Carnegie Mellon University; Carnegie Mellon, 1999–.

DYLAN VITONE, M.F.A. – Massachusetts College of Art..
School of Design

Terry Irwin, Head
Office: Margaret Morrison Carnegie Hall 110
http://design.cmu.edu

Design at Carnegie Mellon

Design is the thoughtful activity that humanizes our environment through visual communication and the shaping of products that help us in our daily lives. Whether in magazines and books, posters and exhibitions, video and film, human-computer interactions, or any of the myriad of everyday products such as furniture, consumer goods, vehicles, or medical equipment, designers play an important role in shaping the form and content of our experience.

Designers are concerned with aesthetics, but they are equally concerned with serving people. This requires more than skill in the fine arts. It also requires knowledge about the needs, desires, expectations, and capabilities of human beings. It requires skills of observation and interpretation that help us understand the people that we want to serve. More than this, however, designers must also understand the technological issues that stand behind effective products. They must understand the materials, tools, and production processes of the modern world. An education in design is an education for the mind as well as the eye and hand.

The emphasis in the School of Design is on professional preparation for an increasingly complex world in which design is an integrative discipline that supports the quality of human interaction in daily life. Designers must be able to integrate aspects of aesthetics and form giving, the social and behavioral sciences, natural sciences, and engineering. In addition, designers must be able to work effectively in teams of experts with specialized knowledge drawn from many disciplines. Therefore, the vision of design operating behind the School of Design contrasts sharply with visions that seek to reduce design to a fine art, a branch of engineering, or an area of the social sciences. The central theme of the School is communication and human experience. This reflects a new humanistic vision of design in the contemporary world, where a premium is placed on the designer’s ability to invent, judge, make decisions, and evaluate for the purpose of improving the quality of life. For the design school at Carnegie Mellon, design is a new liberal art of technological culture.

The School offers two majors in design, with corresponding design minors programs.

B.F.A. in Communication Design

The goal of the Communication Design program is to prepare students with an understanding and mastery of the principles, theories, and skills of communication design. We define communication design as the effective presentation of ideas and information by means of type and image, whether in the traditional medium of print or the new digital medium that supports interactive computer display, multimedia communication technology, and information systems. What is common to the range of experiences in the program is a problem-solving approach to effective and expressive communication, with a special concern for the human being who will be touched by the communication artifact. We emphasize a design practice that is informed with an understanding of the social and cultural dimensions of communication, along with an appreciation of the power of words, images, sound, and movement. This is a forward looking program. While we foster a respect for the rich history of book, letter-form, and print design, we are also fascinated with the potential that technology and new theories of human-machine interaction hold for the design of future modes of communication.

B.F.A. in Industrial Design

The goal of the Industrial Design program is to equip designers for a world that places a high value on the quality of human interactions. We all need products, devices, and designs that support and enhance these exchanges. To this end, we emphasize a design process strongly flavored by user testing, observation, and modeling, while preserving the richness of the visual and formal traditions in the field. The program approaches a balance by speaking clearly to several issues in the design process: how we understand the diverse qualities and needs of human beings, how we respond to those qualities and needs, how we make creative applications of appropriate technologies, how we gain a perspective on the place of design in the economic and social life that is characteristic of contemporary culture, and how we expand our awareness of the place of design in history and in shaping the future.

Design Minors Program

The School also offers a minor in Communication Design and a minor in Industrial Design for well-qualified students. Further information on minors programs is provided earlier in the catalog.

The Design Curriculum

The design curriculum is for students who are interested in a full-time undergraduate study leading to entry-level professional employment or advanced graduate study in the areas of Communication Design or Industrial Design. The first year is a period of discovery, where students in both majors explore studio projects and supporting courses in the ideas and methods of design practice as well as courses in design studies. The second and third years are a period of concentration and development primarily within the student’s major. The fourth year is a period of integration and advanced study, with studio projects involving teams of students from both majors as well as students from related fields. There are studio courses throughout all four years, supported by departmental electives in the ideas and methods of design practice and other courses in the history, theory, and criticism of design. In addition, the School also requires all students to take a substantial number of general education courses offered by other departments throughout the university. General education is an essential part of the education of a professional designer.

The First-Year Experience: Discovery

The first-year program in design provides a broad base for later specialization. Students are introduced to the three main tracks of the department: studio experience, ideas and methods of design practice, and design studies in history, theory, and criticism. Students are exposed to fundamental design processes, techniques, and ideational methods. They learn new ways of seeing and understanding familiar objects, of drawing and visualizing ideas and concepts, and how to use all of the resources of design to give form to ideas. Faculty members review each student’s progress at the end of every semester. Faculty members also counsel students regarding both personal interests and educational objectives, so that a wise choice may be made between majoring in communication design or industrial design. In addition, students also take courses outside of the School for a sound general education.

This is the first-year curriculum for all design students.

First Year

Fall

Studio
51-101 Design Studio I 9
Ideas and Methods
51-121 Design Drawing I 9
Design Studies
51-171 Human Experience in Design 9
General Education
76-101 Interpretation and Argument 9
85-102 Introduction to Psychology 9
99-101 Computing @ Carnegie Mellon 3
or 99-110 Computing @ Carnegie Mellon 3

Spring

Studio
51-102 Design Studio II 9
Ideas and Methods
51-122 Design Drawing II 9
51-132 Introduction to Photo Design 1st mini 4.5
51-134 Photo Design II 2nd mini 4.5

Design Studies
62-100 Critical Histories of the Arts 9
The Second- and Third-Year Experience: Concentration and Development

Following the first-year program, students enter one of the professional design majors: communication design or industrial design. Each option is built around six semesters of required and elective courses, covering the sophomore, junior, and senior years. The courses pose increasingly complex design problems similar to those faced by professional designers. They require students to use all of their creative, technical, and theoretical skills. In addition to studios, each option also requires a series of ideas and methods courses and a series of design studies courses covering design history, theory, and criticism as well as issues of professional practice. Students are also required to take general education courses to gain a broad vision of many disciplines and fields of knowledge that are relevant to design.

Communication Design

This is the second and third-year curriculum for students in communication design, with required courses noted in bold type and other available courses (often open to students of industrial design as well as communication design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student’s schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

Fall

<table>
<thead>
<tr>
<th>Studio</th>
<th>51-201</th>
<th>CD I: Basic Type</th>
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<tbody>
<tr>
<td>Ideas and Methods</td>
<td>51-203</td>
<td>Communication Design Computer Lab</td>
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<tr>
<td>51-241</td>
<td>How People Work</td>
<td></td>
</tr>
<tr>
<td>51-229</td>
<td>Digital Photographic Imaging</td>
<td></td>
</tr>
<tr>
<td>Design Studies</td>
<td>51-271</td>
<td>Design History I</td>
</tr>
<tr>
<td>General Education</td>
<td>xx-xxx</td>
<td>Academic Elective</td>
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Spring

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<th>Studio</th>
<th>51-202</th>
<th>Type II: Organizing Information</th>
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<tbody>
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<td>Ideas and Methods</td>
<td>51-222</td>
<td>Decoding Place</td>
</tr>
<tr>
<td>51-224</td>
<td>Prepping for Pixels &amp; Prints</td>
<td></td>
</tr>
<tr>
<td>Design Studies</td>
<td>51-272</td>
<td>Design History II</td>
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Third Year

Fall

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<th>51-301</th>
<th>CD III: Expressive Type</th>
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<td>Ideas and Methods</td>
<td>51-321</td>
<td>Photographic Narrative</td>
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<td>51-323</td>
<td>Drawing and Communication</td>
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<td>51-327</td>
<td>Introduction to Web Design</td>
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<td>51-333</td>
<td>Poster Design</td>
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<tr>
<td>Design Studies</td>
<td>51-372/398</td>
<td>Design &amp; Social Change</td>
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Industrial Design

This is the second and third-year curriculum for students in industrial design, with required courses noted in bold type and other available courses (usually open to students of communication design as well as industrial design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student’s schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

Fall

<table>
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<th>Generation of Form: Industrial Design I</th>
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<tbody>
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<td>Ideas and Methods</td>
<td>51-241</td>
<td>How People Work</td>
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<td>51-243</td>
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<td>Digital Prototyping (min 2)</td>
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<td>51-272</td>
<td>Design History II</td>
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Spring

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<td>Ideas and Methods</td>
<td>51-242</td>
<td>How Things Work: Mechanics and Electronics</td>
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<tr>
<td>51-246</td>
<td>Visual Communication Fundamentals</td>
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<td>Design Studies</td>
<td>51-274</td>
<td>Design and Social Change</td>
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Third Year

Fall

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<th>51-311</th>
<th>Product Design ID III</th>
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</table>
The Fourth-Year Experience: Integration and Advanced Study

In the senior year, the studio experience is primarily about team projects. These projects typically involve cooperation with an external sponsor or client, with a combination of communication designers and industrial designers working in teams. The client agrees to participate as an information source, consultant, and project critic. All members of the team typically work on different aspects of a complex problem which is defined in conjunction with the client. Individual initiative and self-pacing are essential, but frequent group discussions and client reviews keep each student accountable to the team.

This is the fourth-year curriculum for all students, with required courses noted in bold type and other available courses (usually open to students of both communication design and industrial design) noted in regular type. Each senior signs up for one senior project in each semester.

Fourth Year

Fall (Choose one project.)

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<td>S1-407</td>
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<td>S1-408</td>
<td>12</td>
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<tr>
<td>S1-414</td>
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</tr>
<tr>
<td>xx-xxx Free Elective</td>
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</tbody>
</table>

Other Requirements

General education courses should be selected from other departments throughout the university. Students are strongly advised to select a balanced set of general education electives in addition to Interpretation and Argument, World History and Introduction to Intelligence- from three broad areas of study: arts and humanities, social and behavioral sciences, and natural sciences and engineering, including mathematics. Specific recommendations (and general requirements) for electives in all of these areas are available from advisors in the School of Design. The School places strong emphasis on the value of general education for personal growth as well as professional development. General education electives allow a student to obtain a minor in another department or program, such as business, engineering, professional and technical writing, or architecture.

Students may enroll for no more than 18 units of independent study courses, and no more than one independent study per semester. A minimum 3.0 GPA is required for independent study. Independent study is permitted only in the third and fourth years of the program. Proposals for independent study courses must be developed jointly by the student and a faculty advisor. Guidelines are available from the School.

A minimum GPA of 2.0 is required to maintain Professional Program status. Grades lower than "C" in required Design courses will result in academic probation, suspension, or drop from the School of Design.

Full-time students are required to enroll for a minimum of 45 units per semester (typically five courses). The minimum number of units required for graduation in Design is 360.

Standards

The design curriculum adheres closely to the fundamental professional entry-level standards established by the two leading national design organizations: the American Institute of Graphic Arts (AIGA) and the Industrial Designers Society of America (IDSA). The curriculum is accredited by the National Association of Schools of Art and Design (NASAD).

Applications

The School of Design accepts applications from students who are completing secondary education or who wish to transfer from within
The School also accepts applications from students who wish to transfer from other institutions. Students applying for the program are asked to either 1) submit a portfolio or 2) complete a design project (available as a PDF on the Design web site) as evidence of design ability. This is considered in balance with evidence of academic ability, based on secondary school grades, SAT scores, class rank, and letters of recommendation. The School also accepts applications for the design minors program for a limited number of spaces. Details are available from the design office.

Faculty

ERIC ANDERSON, Associate Professor of Design – M.A., Ohio State University; Carnegie Mellon, 1998–.

MARK BASKINGER, Associate Professor of Design – M.F.A., University of Illinois; Carnegie Mellon, 2003–.


CHARLEE MAE BRODSKY, Professor of Photography – M.F.A., Yale University; Carnegie Mellon, 1978–.

WAYNE CHUNG, Associate Professor of Design – MID, University of the Arts; Carnegie Mellon, 2007–.

SHELLEY EVENSON, Associate Professor of Interaction Design – B.S, Ohio State University; Carnegie Mellon, 2003–.

JODI FORLIZZI, Associate Professor, joint faculty in Design and Human Computer Interaction Institute – MDes, Carnegie Mellon University; Carnegie Mellon, 2000–.

BRUCE HANINGTON, Associate Professor of Design of Environmental and Industrial Design – Master of Environmental and Industrial Design, University of Calgary; Carnegie Mellon, 1998–.

KRISTIN HUGHES, Associate Professor of Design – M.F.A., Virginia Commonwealth University; Carnegie Mellon, 2001–.


STACIE ROHRBACH, Associate Professor of Design – MGD, North Carolina State University; Carnegie Mellon, 2003–.

STEPHEN J. STADELMEIER, Associate Professor of Design – M.S., Cornell University; Carnegie Mellon, 1977–.

DYLAN VITONE, Associate Professor – M.F.A., Massachusetts College of Art; Carnegie Mellon, 2004–.

JOHN ZIMMERMAN, Associate Professor, joint faculty in Design and Human Computer Interaction Institute – MDes, Carnegie Mellon University; Carnegie Mellon, 2002–.

Courtesy Appointments

LIUIS VON AHN, Assistant Professor of Computer Science – Ph.D, Carnegie Mellon University; Carnegie Mellon, 2005–.

JONATHAN CAGAN, George Tallman Ladd Professor of Mechanical Engineering – Ph.D., University of California Berkeley; .

SUGURU ISHIZAKI, Associate Professor of Rhetoric and Visual Design – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2005–.

DAVID S. KAUFER, Professor of English and Rhetoric – Ph.D., University of Wisconsin; Carnegie Mellon, 1980–.

GOLAN LEVIN, Associate Professor of Art – M.S., Massachusetts Institute of Technology; Carnegie Mellon, 2004–.

Special Faculty


EDWARD FISHER JR., Associate Professor of Design, Emeritus;Carnegie Mellon, 1965-1988–.

ROBERT O. SWINEHART, Professor of Design, Emeritus – M.F.A., Northern Illinois University; Carnegie Mellon, 1974–.

HOWARD WORNER, Associate Professor of Design, Emeritus..
School of Drama

Peter Cooke, Head of School
Office: Purnell Center for the Arts, 221

The information contained in this section is accurate as of May 31, 2012 and is subject to change. Please contact the School of Drama with any questions.

The School of Drama at Carnegie Mellon University is the oldest drama program in the country. CMU Drama offers rigorous, world-class classical training in theatre while providing thorough preparation for contemporary media.

As a member of the Consortium of Conservatory Theatre Training Programs, the school chooses students to participate in the program based on their potential ability. Every Drama student is treated as a member of a theatrical organization and must acquire experience in all phases of the dramatic arts. Students are also asked to broaden their knowledge through courses in the other colleges of the university. The undergraduate Drama program, which incorporates approximately 200 students, leads to a Bachelor of Fine Arts in Drama. The options available are: Acting, Music Theatre, Design, Production Technology and Management, Directing, Dramaturgy, and Theatre Studies. The production of plays, a natural extension of demanding class work, is our lab, and constitutes one of the school’s major activities.

The choice of texts used is determined by the particular needs of current students. Each semester, 15 to 25 lab productions, directed by faculty, guest directors, and advanced students, are presented in our three theatre spaces. The labs range from completely mounted, full-length dramatic and musical works to more simply produced directing projects and one-acts. The Drama program is rigorous and exacting, making demands on students that necessitate good health, a willingness to work and a commitment to professional discipline at all times. Because of full daytime class work and heavy production schedules, much production preparation takes place in the evening. Drama students, therefore, are advised to live in residence halls or in the immediate vicinity of the campus.

Acting Option

The Acting option is designed to prepare the student for immediate entry into the profession. It is a sequence-based training program with accumulative skills building upon each other over the course of four years. It is a conservatory training course, and the curriculum focuses primarily on the technique and craft of theatre. At the same time it offers skills that are applicable to all media. Courses in acting, voice, speech, movement, and theatre history are integral parts of the program at all four levels.

In addition to studio classes, Acting majors are required to take at least one liberal arts class each semester outside the school of drama to expand their intellectual curiosity and worldview.

All students must demonstrate a commitment to growth, show continued progress in their work and in the knowledge of their craft, and show a respect for professional standards in discipline, quality and ethics.

The freshman year is a discovery year and provides an introduction to basic skills-working from self, learning to play objectives and actions and the beginning of character exploration.

In the sophomore year these skills are solidified and deepened as more sophisticated, verbally complex material is introduced, through a focus on in-depth scene study, both contemporary and Shakespeare.

In the junior year students continue to develop their craft by investigating a variety of styles, including Greek, Brecht, and Restoration. Skills are now tested and strengthened through public performance.

The senior year provides a bridge from training to the professional world and offers the opportunity to appear on the School of Drama’s main stage.

At the end of the senior year, students are introduced to the profession through Showcase performances in New York City and Los Angeles. The privilege to participate in Showcase is subject to the approval of the School of Drama faculty and as a rule is granted only to students who have obtained the necessary credits for graduation.

Music Theatre Option

The students in the Music Theatre program share the training philosophy and much of the same curriculum as others in the acting option. In addition, they take courses particular to the demands of Music Theatre. These include private voice along with training in a variety of dance techniques (Ballet, Jazz, Tap and Broadway Styles) and music theatre styles and skills.

Design Option

Design students are expected to develop artistic ability in the conception and execution of scene, lighting, sound and costume design for plays of all periods under varying theatrical conditions. Students may elect to have a focus on one or two areas but must have a solid background in all four. Freshmen in design receive instruction in drawing and painting, three-dimensional techniques, and in the application of basic design principles through courses in drawing and design. Sophomores learn to apply design principles to the theatre through research, play analysis, and studies in the fundamentals of scene, lighting, sound and costume design. Design assignments cover various styles and periods and include the preparation of models, renderings, and working drawings, lighting storyboards, and light plots. Juniors and Seniors take specialized courses in two areas of stage design and are expected to head studio and main-stage production crews. As part of the degree work, juniors may design sets, lights, sound or costumes for a production in the Studio Theatre and seniors may design sets, lights, sound or costumes for a Master’s thesis show or a main-stage production. Designing for lab productions, both those that are highly resourced and those that are moderately resourced, requires a variety of creative approaches, preparing designers for a variety of real-world situations.

Directing Option

The John Wells Directing Program promotes creativity, intellectual curiosity, a broad and well-rounded understanding of the theatre and leadership ability. It provides a detailed exploration of the technique of directing for stage and for camera. The curriculum is designed for those serious about the art of directing and intending to pursue a career in theatre, film or television.

Course work in scene design, lighting and costume design develops the students’ visual sophistication as well as an understanding of how these elements combine in practical production situations. Stage management skills are studied and practiced. Theatre history, criticism, play-writing, play development and theatre management classes introduce the student to the wide range of knowledge necessary for directing. There are many avenues open for practical application: scene work in class, a short film written and directed by the students, opportunities in multi-camera directing and a studio project. The broad scope of the directing curriculum encourages the director’s interaction with all the theatrical disciplines. Collaboration in all forms, so necessary to the art, is the goal.

Production Technology and Management (PTM) Option

The Production Technology and Management program develops the technologists and managers of the future with an intensive curriculum designed to synthesize academic development and production experience. The curriculum focuses on the production requirements of live performance, in the form of traditional theatrical presentation, while also providing exposure to television, film and emerging technology-based art forms. Integrated in a world class research university environment, the School of Drama is uniquely positioned to contribute to the advancement of the collaborative arts. The goal of the PTM program is to prepare today’s students to become tomorrow’s leading professionals in the entertainment industry.

All undergraduate students begin with the development of visual and written communication skills. The first four semesters immerse the student in a range of collaborative and individual studies: scenery, costume, sound and lighting design fundamentals; dramatic structure and interpretation; manual and computer-based drafting; perspective and figure drawing; fundamentals of directing; production management and preparation; history of art and history of architecture and décor. The last four semesters focus in the student’s analytical skills within their chosen area of concentration: technical direction or stage/production management.

Technical Directors are offered classes in: material applications, metalworking techniques, structural design, scenic crafts, fabrication design and detailing, machinery design, rigging techniques, power system and electronic design fundamentals, introduction to sound design, automation system technology, technical management and production management.

Technical Directors may take a single semester internship at an approved regional or commercial producing organization, in lieu of one semester of study. Student selected elective courses, outside the School of Drama, provide balance and breadth to the professional undergraduate education offered in the PTM program of study.

Stage Managers and Production Managers are offered classes in: stage management, production planning and scheduling, theater management,
**Acting I**

**Acting I**

**Actor Dance III**

**Showcase**

**Business of Acting**

**Voice/Alexander I**

**Future Stages for Undergrad Actors**

**5-9**

**Actor Dance II**

**5**

**Conservatory Hour**

**Voice and Speech II**

**Actor Dance III**

**5**

**6-9**

**Singing for Actors II**

**6**

**Foundations of Drama II**

**2**

**Showcase**

**2**

**Voice/Alexander I**

**Junior Auditioning (Optional)**

**3**

**10**

**6**

**Movement III**

**9**

**6**

**2**

**Speech III**

**9**

**4**

**T ext for Actors**

**6-9**

**3**

**Voice and Speech II**

**Actor Dance II**

**Acting for the Camera**

**Movement III**

**1**

**2**

**Non-Drama Elective**

**59-101 Computing @ Carnegie Mellon 3**

**54-301 Acting III 10**

**54-303 Speech III 6**

**54-305 Voice/Alexander III 5**

**54-307 Movement III 5**

**54-312 Acting Symposium III 16**

**54-325 Actor Dance III 2**

**54-409 Theatre Lab for Undergraduates Var.**

**xx-xxx Non-Drama Elective 6-9**

**54-317 Singing for Actors III (Optional) 2**

**54-xxx Junior Auditioning (Optional) 2**

**Spring**

**54-302 Acting IV 10**

**54-304 Speech III: Accents & Dialects 6**

**54-306 Voice/Alexander III 5**

**54-308 Movement III 5**

**54-312 Acting Symposium III 16**

**54-325 Actor Dance III 2**

**xx-xxx Non-Drama Elective 6-9**

**54-318 Singing for Actors III (Optional) 2**

**54-xxx Junior Auditioning (Optional) 2**

**Junior Year**

**Fall**

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<td>54-104</td>
<td>Speech I</td>
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<td>54-106</td>
<td>Voice/Alexander I</td>
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<td>76-101</td>
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**Sophomore Year**

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<td>54-281</td>
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**Junior Year**

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**Senior Year**

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<td>Future Stages for Undergrad Actors</td>
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<td>54-411</td>
<td>Acting Symposium IV</td>
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<td>54-413</td>
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<td>54-437</td>
<td>Acting IV</td>
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<td>54-493</td>
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**Curriculum**

The School of Drama curriculum is continuously reviewed and modified in an effort to provide the best conservatory experience for undergraduate students in the School of Drama. The following curriculum is subject to change. Not all requirements are listed, and units are often variable within each Option based on performances, production assignments, and individual projects.

**Acting Option**

**Freshman Year**

**Fall**

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<td>Voice/Alexander I</td>
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<td>54-107</td>
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<tr>
<td>54-120</td>
<td>Text</td>
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<td>54-159</td>
<td>Production Symposium I</td>
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<td>54-175</td>
<td>Conservatory Hour</td>
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<tr>
<td>54-177</td>
<td>Foundations of Drama I</td>
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<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
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<td>99-101</td>
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### Junior Year

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### Design Option

#### Freshman Year

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<tr>
<td>54-151</td>
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<td>54-169</td>
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<td>54-175</td>
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<td>54-177</td>
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#### Sophomore Year

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**Sophomore Year**

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<td>Fall - ALL DESIGN</td>
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**Senior Year**

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**Notes:**

* Foundations of Drama I will be taken only one semester in the freshman year.
** Foundations of Drama II will be taken only one semester in the sophomore year. Sophomore Designers will be required to take an approved HSS course during the semester they are not taking Foundations of Drama II.
*** All Designers are required to complete 6 units of Special Topics in Drama: History, Literature and Criticism (two 3-unit minis, or one 6-unit full semester course.) It may be taken at any time after Foundations II has been completed. Costume Designers are required to take Special Topics the spring semester of sophomore year.

Designers may choose to pursue dual disciplines - this curriculum is available and customizable to individual student needs. Students should meet with their faculty advisor to discuss the possibilities.
### Directing Option

#### Freshman Year

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### Production Technology and Management (PTM) Option

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**NON-DRAma ELECTIVES:** Directors take a minimum of seven Non-Drama Electives, 6-9 units each.

**Notes:**

- Foundations of Drama I will be taken only one semester in the freshman year.
- Foundations of Drama II will be taken only one semester in the sophomore year.
- Foundations Directors will be required to take an approved HSS course during the semester they are not taking Foundations II.
- All Directors are required to complete 6 units of Special Topics in Drama: History, Literature and Criticism during their junior or senior year (two 3-unit minis, or one 6-unit full semester course.) Directors may choose to take History of Architecture and Decor or History of Clothing to fulfill this requirement.
- One semester of Directing Production IV - Senior Thesis Play is required. Second semester is optional.

#### Sophomore Year

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#### Junior Year

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<td>54-166</td>
<td>Introduction to Sound Design for Theatre</td>
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### Junior Year

**Fall - ALL PTM**
- 54-278 Technical Direction I 6
- 54-333 Production Personnel Management 6
- 54-361 Production Preparation III Var.
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6
- xx-xxx Directed Elective 3-12
- xx-xxx Non-Drama Elective 6-9

**Fall - PTM TECHNICAL DIRECTION**
- 54-353 Structural Design I ** 9
  or 54-366 Physics of Stage Machinery

**Fall - PTM PM/SM**
- 54-277 Stage Management I 6
- 54-139 Stage Management Seminar 3

**Spring - ALL PTM**
- 54-475 Theatre Management 6
- 54-362 Production Preparation III Var.
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6
- xx-xxx Directed Elective 3-12
- xx-xxx Non-Drama Elective 6-9

**Spring - PTM TECHNICAL DIRECTION**
- 54-354 Structural Design II ** 9
  or 54-365 Machine Design I
- 54-378 Technical Direction II 9
- 54-376 Entertainment Rigging 3

**Spring - PTM PM/SM**
- 54-278 Stage Management I 6
- 54-346 Stage Management Seminar 3
- 54-456 Production Management Workshop 3
- 54-380 Music Reading for Drama Technicians 3

**Senior Year**

**Fall - ALL PTM**
- 54-355 30 Hour Osha 6
- 54-461 Production Preparation IV -1
- xx-xxx Directed Elective 1-12
- xx-xxx Non-Drama Elective 6-12
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6

**Fall - PTM TECHNICAL DIRECTION**
- 54-477 Technical Direction II 6
- 54-353 Structural Design I ** 9
  or 54-366 Physics of Stage Machinery

**Fall - PTM PM/SM**
- 54-359 Stage Management and Actors Equity 3
- 54-439 Stage Management Seminar 3
- 54-453 Production Management Workshop I 3

**Spring - ALL PTM**
- 54-462 Production Preparation IV Var.
- 54-464 PTM Professional Practice 3
- xx-xxx Non-Drama Elective 6-12
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6

**Spring - PTM TECHNICAL DIRECTION**
- 54-354 Structural Design II 9
  or 54-466 Advanced Media Design II
- 54-466 Advanced Media Design II 2
- 54-480 Technical Direction IV 6

**Spring - PTM PM/SM**
- 54-356 Stage Management TV Project 3
- 54-440 Stage Management Seminar 1-1
- 54-456 Production Management Workshop 3
- 54-xxx Management III 6

**NON-DRAMA ELECTIVES:**
- PTM students take a minimum of seven Non-Drama Electives, 6-9 units each.

**Notes:**
- * Foundations of Drama I will be taken only one semester in the freshman year.
- ** Foundations of Drama II will be taken only one semester in the sophomore year. Sophomore PTM students will be required to take an approved HSS course during the semester they are not taking Foundations II.

*** All PTM students are required to complete 6 units of Special Topics in Drama: History, Literature and Criticism during their junior or senior year (two 3-unit minis, or one 6-unit full semester course.)

~ Classes offered in alternating years.

### Dramaturgy Option

#### Freshman Year

**Fall**
- 54-177 Foundations of Drama I 6
- 54-109 Dramaturgy 1: Approaches to Text 9
- 54-200 Ghost Light Forum 1
- 54-175 Conservatory Hour 1
- 76-101 Interpretation and Argument 9
- 82-xxx Modern Language * 9
- xx-xxx Directed Elective 9
- 99-101 Computing @ Carnegie Mellon 3

**Spring**
- 54-178 Foundations of Drama I 6
- 54-284 Dramaturgy 2: History and Practice 9
- 54-160 Production Symposium I 6
- 54-176 Conservatory Hour 1
- 62-100 Critical Histories of the Arts 9
- 82-xxx Modern Language * 9
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9

#### Sophomore Year

**Fall**
- 54-xxx Dramaturgy 3/4/5/6 **
- 54-299 Dramaturgy Production: Practical Observation Var.
- 54-200 Ghost Light Forum 1
- 54-239 History of Architecture and Decor -1
- 54-245 History of Clothing -1
- 76-xxx Directed English theory course 9
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9

**Spring**
- 54-xxx Dramaturgy 3/4/5/6 **
- 54-xxx Intro Design course (field of choice) 9
- 54-200 Ghost Light Forum 1
- 54-299 Dramaturgy Production: Practical Observation Var.
- xx-xxx Directed Elective 9
- xx-xxx Directed Elective 9
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9

#### Junior Year

**Fall**
- 54-xxx Dramaturgy 3/4/5/6 ***
- 54-387 Dramaturgy: Production I -1
- 54-200 Ghost Light Forum 1
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6
- 54-463 Dramaturgy Research Hours Var.
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9

**Spring**
- 54-xxx Dramaturgy 3/4/5/6 9
- 54-388 Dramaturgy: Production I -1
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6
- 54-463 Dramaturgy Research Hours Var.
- xx-xxx Directed Elective 9
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9

#### Senior Year

**Fall**
- 54-xxx Dramaturgy 3/4/5/6 **
- 54-487 Dramaturgy: Production II -1
- 54-200 Ghost Light Forum 1
- 54-381 Special Topics in Drama: History, Literature and Criticism *** 6
- 54-463 Dramaturgy Research Hours Var.
- 54-489 Dramaturgy: Internship – 9
- xx-xxx Directed Elective 9
- xx-xxx Non-Dramaturgy Elective 6-9
Spring
54-xxx  Dramaturgy 3/4/5/6**  Units
54-200  Ghost Light Forum  9
54-381  Special Topics in Drama: History, Literature and Criticism ***  6
54-463  Dramaturgy Research Hours  9
54-488  Dramaturgy: Production II  1
54-490  Dramaturgy: Internship  9
xx-xxx  Directed Elective  9
xx-xxx  Non-Dramaturgy Elective  6-9

DIRECTED ELECTIVES: ENGLISH  Units
Dramaturgy students take 6 English courses (four 200-300 level, two 400-level)  54
Sample Recommended English Electives:
76-245  Shakespeare: Histories and Tragedies  9
76-247  Shakespeare: Comedies and Romances  9
76-330  Medieval Literature  9
76-331  Renaissance Literary and Cultural Studies  9
76-335  20th Century Literary and Cultural Studies  9
76-431  Chaucer  9
76-432  Advanced Seminar in African American Studies  9
76-438  Advanced Seminar in American Literary and Cultural Studies  9

DIRECTED ELECTIVES: HISTORY  Units
Dramaturgy students take at least 3 History courses (two 200-level and one 300-level). One course must focus on History pre-1900, and one must focus on African, Asian, Latin American, or Caribbean studies.  27
DIRECTED ELECTIVES: EUROPEAN STUDIES  Units
Dramaturgy students take one European Studies course (cannot be an English course, but can be a History course)  9
DIRECTED ELECTIVES: MODERN LANGUAGE  Units
Dramaturgy students take at least one Modern Language course at the 200-level or above.  12
DIRECTED ELECTIVES: DRAMA  Units
Dramaturgy students take at least two of the following Drama courses:
54-101  Acting I  10
54-187  Introduction to Playwriting  9
54-221  Directing I: Fundamentals  9

NON-DRAMATURGY ELECTIVES:  Units
Dramaturgy students take a minimum of seven Non-Drama Electives, 6-9 units each.

Notes:
* Dramaturgy students starting a modern language at the 100-level should begin in the fall of freshman year.
** Dramaturgy 3, 4, 5, and 6 may be taken in any order in the sophomore, junior, and senior year.
*** Dramaturgy students are required to take a total of 18 units of Special Topics in Drama: History, Literature and Criticism during their junior and senior year (3-unit mini or 6-unit full semester courses may be counted in total).
~ Dramaturgy Internship may be completed in the summer, fall, or spring semester of senior year.

Faculty
BARBARA ANDERSON, Professor, Drama Design – M.F.A., Yale University; Carnegie Mellon, 1968–.
WENDY ARONS, Associate Professor, Dramatic Literature – Ph.D., University of California, San Diego; Carnegie Mellon, 2007–.
NATALIE BAKER-SHIRER, Associate Professor, Voice & Speech – M.F.A., University of Pittsburgh; Carnegie Mellon, 1992–.
CLAUDIA BENACK, Associate Teaching Professor, Music Theatre – M.F.A., Carnegie Mellon; Carnegie Mellon, 1993–.
DICK BLOCK, Teaching Professor, Design – M.F.A., Northwestern University; Carnegie Mellon, 1988–.
DAVID BOEVERS, Associate Professor, Production Technology and Management, Option Coordinator, PTM – M.F.A., Yale University; Carnegie Mellon, 2000–.
JAMES CATON, Associate Teaching Professor, DanceCarnegie Mellon, 1988–.
JUDITH CONTE, Teaching Professor, Dance – B.F.A., University of Wisconsin/ Milwaukee; Carnegie Mellon, 1976–.
TOME COUSIN, Assistant Professor, Dance Carnegie Mellon, 2011–.
THOMAS DOUGLAS, Associate Teaching Professor, Voice – M.M., Duquesne University; Carnegie Mellon, 1991–.
The School of Music offers a Bachelor of Fine Arts in the following areas:

- Conference rooms are also available in the library.
- Library houses a fine collection of books, records, and scores. Listening and Hall, Alumni Concert Hall, and Mellon Institute Auditorium. The Hunt Margaret Morrison Hall, and in Skibo Gymnasium. All teaching, rehearsal, and double major programs. These opportunities significantly increase a student's career options and marketability in the changing professional world of music.

The School of Music jointly with the School of Computer Science and the Carnegie Institute of Technology offers a Bachelor of Science in the following areas:

- Conducting Minor
- Music Education Certification Minor
- Music Technology Minor
- Music Theory Minor

The School of Music offers a Bachelor of Fine Arts in the following areas:

- Piano Pedagogy Certificate
- Dalcroze Eurhythmics Certificate

This program is designed to prepare teachers in the Dalcroze approach to music learning. The course of study includes eurhythmics, piano improvisation, and Dalcroze pedagogy. Carnegie Mellon undergraduates may enter the Dalcroze Training Program during their junior year. However, the certificate will be granted only upon completion of their undergraduate degree. This program is recommended particularly to students who would like to incorporate Dalcroze principles into their teaching and to those who want to obtain more experience in this field.

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The teaching facilities of the School of Music are located on the ground

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- main, and mezzanine floors of the College of Fine Arts, on the first floor of Margaret Morrison Hall, and in Skibo Gymnasium. All teaching, rehearsal, and practice rooms are equipped with Steinway pianos. Music students also have access to a state-of-the-art recording studio and music technology cluster. Performances take place in Kresge Recital Hall, Carnegie Music Hall, Alumni Concert Hall, and Mellon Institute Auditorium. The Hunt Library houses a fine collection of books, records, and scores. Listening and conference rooms are also available in the library.

School of Music Options

- Performance (Instrumental, Voice, Piano, Organ)
- Composition

To earn a Bachelor's degree in either of these options, a candidate must satisfactorily fulfill all the requirements of the School of Music.

Within the options listed above students may elect specializations in the following areas:

- Dalcroze Eurhythmics Certificate
- Piano Pedagogy Certificate
- Accompanying Minor
- Conducting Minor
- Music Education Certification Minor
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The teaching facilities of the School of Music are located on the ground,
Candidates for the Bachelor of Fine Arts degree in performance are required to give public performances in their junior and senior years. Candidates for the Bachelor of Fine Arts degree in string performance are required to give public performances in their sophomore, junior, and senior years.

Candidates for the Bachelor of Fine Arts degree in applied areas other than piano are required to pass a piano proficiency test.

Candidates for all School of Music degrees are required to pass four repertoire proficiency tests, and to participate in a major choral ensemble or major instrumental ensemble as assigned and to attend Convocation every semester of residence in the School of Music.

Music Curriculum

The music curriculum is based on the following five building blocks:

1. Studio — This is the heart of the school. Students receive individualized instruction with senior faculty in their major area of study: performance or composition.

2. Theory — These courses are designed to help students develop listening skills, to acquire theoretical knowledge, to recognize structural techniques and manipulate technological resources. It includes courses in sight-reading, ear-training, eurhythmics, harmony, contrapuntal techniques, analysis of musical forms, 20th-21st century techniques, orchestration, score reading, and electronic and computer music for compositional and educational purposes. One music support course in the piano, organ, and instrumental curricula must be a theory course.

3. History - These courses cover in depth the music of the western world and survey the styles and musical structures of non-western music.

4. Ensemble — This area includes student participation in some of the following ensembles: Carnegie Mellon Philharmonic, Wind Ensemble, Concert Choir, Repertory Chorus, Baroque Ensemble, Contemporary Ensemble, Jazz Ensemble, Jazz Vocal Ensemble, Repertoire Orchestra, Production, Percussion Ensemble, and chamber groups.

5. Academics — The School of Music requires one general studies course (outside of the School) each semester and six semesters of elective courses for graduation. These accumulated credits may be applied to minors or majors in other disciplines. Exceptional students in good academic and musical standing within the School are permitted to take additional courses beyond the number required for graduation. There is no charge for extra credits taken at Carnegie Mellon. One elective course in the piano, organ and instrumental curricula must be a literature, repertoire, and pedagogy course.

Credits — The total number of units required for graduation is 407 for voice majors; 392 for composition majors; 380 for instrumental, organ, and piano majors. Three units equal one credit.

Piano

First Year

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<td>Collaborative Piano Skills I</td>
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<td>Harmony I</td>
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<td>Eurythmics I</td>
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<td>Solfege I</td>
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<td>Introduction to Repertoire and Listening for Musicians</td>
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<td>Introduction to Music Technology</td>
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<td>99-101</td>
<td>Computing at Carnegie Mellon</td>
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### Voice

A voice major must also complete an advanced language course of at least 9 units. Recommended: a domestic or international program, after the sophomore year, which includes intensive study for credit in the Italian, German, or French language.

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Voice

A voice major must also complete an advanced language course of at least 9 units. Recommended: a domestic or international program, after the sophomore year, which includes intensive study for credit in the Italian, German, or French language.

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### First Year

**Fall**
- 57-100 Convocation
- 57-xxx Studio
- Major Ensemble
- Major Choral Ensemble
- Harmony I
- Eurhythmics I
- Softedge I
- Introduction to Repertoire and Listening for Musicians
- Introduction to Music Technology
- Computing @ Carnegie Mellon
- Interpretation and Argument

**Spring**
- 57-100 Convocation
- 57-xxx Studio
- Major Ensemble
- Major Choral Ensemble
- Harmony II
- Eurhythmics II
- Softedge II
- Repertoire and Listening for Musicians I
- Music History I
- Critical Histories of the Arts

### Second Year

**Fall**
- 57-100 Convocation
- 57-xxx Studio
- Major Ensemble
- Keyboard Studies
- Form and Analysis
- Eurhythmics III
- Softedge III
- Repertoire and Listening for Musicians II
- Music History II
- General Studies Course

**Spring**
- 57-100 Convocation
- 57-xxx Studio
- Major Ensemble
- Keyboard Studies
- Counterpoint in Theory and Application
- Eurhythmics IV
- Softedge IV
- Repertoire and Listening for Musicians III

### Third Year

**Fall**
- 57-100 Convocation
- Studio
- Major Ensemble
- Chamber Music
- Music Support Course (Theory/History)
- General Studies Course
- Elective

**Spring**
- 57-100 Convocation
- Studio
- Major Ensemble
- Chamber Music
- Music Support Course (Theory/History)
- General Studies Course
- Elective

### Fourth Year

**Fall**
- 57-100 Convocation
- Studio
- Major Ensemble
- Chamber Music
- Music Support Course (Theory/History)
- General Studies Course
- Elective

**Spring**
- 57-100 Convocation
- Studio
- Major Ensemble
- Chamber Music
- Music Support Course (Theory/History)
- General Studies Course
- Elective

### Instrumental

A string major must also complete two semesters of Chamber Music in the sophomore year.

### Composition

**First Year**
- 57-100 Convocation
- Major Studio (Composition)
- Major Ensemble
- Keyboard Studies
- Harmony II
- Eurhythmics II
- Softedge I
- Repertoire and Listening for Musicians I
- Music History I
- Critical Histories of the Arts

**Second Year**
- 57-100 Convocation
- Major Studio (Composition)
- Major Ensemble
- Keyboard Studies
- Harmony II
- Eurhythmics II
- Softedge II
- Repertoire and Listening for Musicians II
- Music History II
- General Studies Course

**Spring**
- 57-100 Convocation
- Major Studio (Composition)
- Major Ensemble
- Keyboard Studies
- Harmony II
- Eurhythmics II
- Softedge II
- Repertoire and Listening for Musicians II
- Music History II
- Critical Histories of the Arts
Dalcroze Eurhythmics Certificate 30 units

57-465 Eurhythmics Applications for Performing and Teaching 6
57-466 Eurhythmics Applications for Performing and Teaching 6
57-491/692 Dalcroze Pedagogy/Practice Teaching 6
57-350 Dalcroze Piano Improvisation 6
xx-xxx Creative Movement/Choreography 3
57-643/642 Dalcroze Research Paper 3
Admission Requirements:

The student must apply to the music education faculty no earlier than spring of the freshman year.

Corequisite General Courses 45 units

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Corequisite Music Courses 18 units

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General Education Courses 36 units

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Music Education Methods Courses 48 units

General Methods Courses

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<td>57-355</td>
<td>Secondary Guided Teaching</td>
<td>3</td>
</tr>
</tbody>
</table>
Applied Area Methods Courses
57-207  Secondary Studio Var.
57-360  Brass Methods 3
57-361  Percussion Methods 3
57-363  String Methods 3
57-362  Woodwind Methods 3
57-607  Vocal Methods 3

Band Methods Courses
57-334  Fundamentals of Marching Band 3
57-370  Stage Direction 3
57-333  Band and Choral Arranging 6

Music Education Teaching Courses  15 units
57-608  Observation 3
57-603  Practice Teaching (Elementary) 6
57-604  Practice Teaching (Secondary) 6

Minimum units required for Music Education Minor: 99

Minor in Music Technology for Students in the School of Music
Admission Requirements:
The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Courses  18 units
57-152  Harmony I 9
57-161  Eurhythmics I 3
57-181  Solfege I 3
57-189  Introduction to Repertoire and Listening for Musicians 3

Sound Recording Courses  21 units
Music Technology/Sound Courses (Choose 3)  21 units
Choose three courses. One of the three courses must be either Introduction to Computer Music or Electronic and Computer Music. (Note that 15-112 is a prerequisite for 15-322; 57-101 or 57-171 is a prerequisite for 57-347.)
33-114  Physics of Musical Sound 9
57-377  Psychology of Music 9

Minimum units required for Music Technology Minor: 45

Minor in Music Theory for Students in the School of Music
Admission Requirements:
The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Courses  18 units
57-152  Harmony I 9
57-161  Eurhythmics I 3
57-181  Solfege I 3
57-189  Introduction to Repertoire and Listening for Musicians 3

Advanced Theory Courses (Choose 3)  21 units
See theory courses on the Music Support Courses Two-Year Rotation list. It is available on the insideMusic website (http://music.cfa.cmu.edu). A graduate course may be taken with the permission of the instructor.

Graduate Theory Course (Choose 1)  6-9 units
See graduate theory courses on the Music Support Courses Two-Year Rotation list. It is available on the insideMusic website (http://music.cfa.cmu.edu). The course is to be chosen with the advisor's approval.

Support Courses  18 units
33-114  Physics of Musical Sound 9
57-377  Psychology of Music 9

Minimum units required for Music Theory Minor: 45

Minor in Music Performance/Music (Composition) for Students in the School of Music
Admission Requirements:
1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
Faculty

DOUGLAS AHLSTEDT, Associate Professor of Voice – M.M., Eastman School of Music; Carnegie Mellon, 1998–.

CHRISTOPHER ALLEN, Artist Lecturer in Percussion.

ALBERTO ALMARZA, Associate Professor of Flute – M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991–.

DONNA AMATO, Artist Lecturer in Piano and Staff Accompanist – B.M., University of Arizona; Carnegie Mellon, 1998–.

JENNIFER AYLMER, Special Faculty.

LEONARDO BALADA, University Professor of Composition – Diploma, The Juilliard School of Music; Carnegie Mellon, 1970–.

JEANNE BAXTRESSER, Vira I. Heinz University Professor of Flute – B.M., The Juilliard School of Music; Carnegie Mellon, 1997–.

SCOTT BELL, Artist Lecturer in OboeCarnegie Mellon, 1994–.

NEAL BERNTSEN, Artist Lecturer in Trumpet – M.M., Northwestern University; Carnegie Mellon, 2003–.

RAYMOND BLACKWELL, Vocal Coach and Staff Accompanist – M.M., SUNY Binghamton; Carnegie Mellon, 2003–.

JEREMY BRANSON, Artist Lecturer in PercussionCarnegie Mellon, 2009–.

MURRAY CREWE, Artist Lecturer in Bass TromboneCarnegie Mellon, 2001–.

CYNTHIA DE ALMEIDA, Artist Lecturer in Oboe – M.M., Temple University; Carnegie Mellon, 1991–.

MICHELE DE LA REZA, Assistant Teaching Professor of Coaching and Accompanying – M.M., Duquesne University; Carnegie Mellon, 1991–.

ROSEANNA IRWIN, Associate Teaching Professor of Coaching and Accompanying – M.M., Duquesne University; Carnegie Mellon, 1992–.

STEPHEN KOSTYNIUK, Artist Lecturer in French Horn.

LANCE LADUKE, Artist Lecturer in Euphonium – B.M., Michigan State University; Carnegie Mellon, 2003–.

CARLA LAROCCA, Assistant Teaching Professor of Keyboard Studies – M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991–.

ELIZABETH LAWRENCE, Artist Lecturer in Jazz Voice – M.M., Manhattan School of Music; Carnegie Mellon, 1996–.


HANNA WU LI, Professor of Piano and Piano Pedagogy – M.M., Northwestern University; Carnegie Mellon, 1969–.

STEPHEN NEELY, Artist Lecturer in Eurhythmics – M.M., Carnegie Mellon University; Carnegie Mellon, 1997–.

ANTHONY LORING MCKAY, Professor of Drama – B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985–.

LUIZ MANRIQUEZ, Associate Teaching Professor in Coaching and Accompanying – M.M., Carnegie Mellon University; Carnegie Mellon, 1992–.

JOHN MARCINIZYN, Artist Lecturer in Guitar – Ph.D., University of Pittsburgh; Carnegie Mellon, 1991–.

MONIQUE MEAD, Director of Music Entrepreneurial Studies.

STEPHEN NEELEY, Artist Lecturer in Eurhythmics – M.M., Carnegie Mellon University; Carnegie Mellon, 1998–.

RODRIGO OJEDA, Staff AccompanistCarnegie Mellon, 2011–.

BENJAMIN OPIE, Artist Lecturer in Music Technology – M.M., Duquesne University; Carnegie Mellon, 2005–.

NATALIE OZEAS, Associate Head and Professor of Music Education – Ed.D., University of Pittsburgh; Carnegie Mellon, 1989–.

ROBERT PAGE, Paul Mellon University Professor of Music and Director of Choral and Opera Studies – M.M., Indiana University; Carnegie Mellon, 1976–.

MILDRED MILLER POSVAR, Artist Lecturer in Voice – BM, Cleveland Institute of Music; Carnegie Mellon, 1981–.

DAVID PREMO, Artist Lecturer in CelloCarnegie Mellon, 1994–.

RICHARD RANDALL, Assistant Professor of Music Theory – Ph.D., Eastman School of Music; Carnegie Mellon, 2008–.

CHRISTOPHER RUTH, Artist Lecturer in Music History.

MICHAEL RUSINEK, Artist Lecturer in ClarinetCarnegie Mellon, 1998–.

VAHAN SARGSYAN, Staff Pianist.

SERGEY SCHEPKIN, Associate Professor of Piano – D.M.A., New England Conservatory; Carnegie Mellon, 2003–.
MARY BETH GLASGOW SCHOTTING, Artist Lecturer in Violin.

STEPHEN SCHULTZ, Associate Teaching Professor of Music History and Flute – M.M., San Francisco State University; Carnegie Mellon, 2002–.

RICCARDO SCHULZ, Associate Teaching Professor and Director of Recording Activities – M.A., University of Pittsburgh; Carnegie Mellon, 1988–.

MARIA SPACAGNA, Associate Professor of Voice.

HENRY SPINELLI, Artist Lecture in Piano Literature and Repertoire.

TERRY STEELE, Artist Lecturer in Saxophone – Carnegie Mellon, 2008–.

LEWIS STROUSE, Associate Teaching Professor in Music Education – D.A., Ball State University; Carnegie Mellon, 1992–.

PETER SULLIVAN, Artist Lecturer in Trombone – Carnegie Mellon, 2000–.

DANIEL TEADT, Artist Lecturer in Voice.

MARILYN TAFT THOMAS, Professor of Music – Ph.D., University of Pittsburgh; Carnegie Mellon, 1981–.

THOMAS THOMPSON, Associate Teaching Professor of Clarinet – M.M., Northwestern University; Carnegie Mellon, 1986–.


REZA VALI, Associate Professor of Composition – Ph.D., University of Pittsburgh; Carnegie Mellon, 1988–.

GRETCHEN VAN HOESEN, Artist Lecturer in Harp – M.M., The Juilliard School; Carnegie Mellon, 1985–.

KAREN ROETHLISBERGER VERM, Chamber Music Coordinator and Staff Accompanist – M.M., Cincinnati Conservatory; Carnegie Mellon, 2004–.

GEORGE VOSBURGH, Artist Lecturer in Trumpet – B.A., University of Rochester; Carnegie Mellon, 2003–.

JAMES WHIPPLE, Artist Lecturer in Music Theory –BA, Carnegie Mellon University; Carnegie Mellon, 1995–.

COLETTE JOUSSE WILKINS, Artist Lecturer in Solfege – First Prize, Conservatoire National de Versailles, France; Carnegie Mellon, 1974–.

DONALD WILKINS, Professor Emeritus of Music – M.A., Harvard University; Carnegie Mellon, 1966–.

ANNE MARTINDALE WILLIAMS, Artist Lecturer in Cello – Diploma, Curtis Institute of Music; Carnegie Mellon, 1987–.

CHRISTOPHER WU, Artist Lecturer in Violin – Carnegie Mellon, 2009–.


RONALD ZOLLMAN, Associate Professor and Director of Orchestral Studies – High Diploma in Orchestral Conducting, Royal Brussels Conservatory; Carnegie Mellon, 2009–.
The Marianna Brown Dietrich College of Humanities and Social Sciences

John P. Lehoczky, Dean
Brian Junker, Associate Dean
Joseph E. Devine, Associate Dean for Undergraduate Studies
Gloria P. Hill, Assistant Dean and Director, Dietrich College Academic Advisory Center
http://www.hss.cmu.edu

The Dietrich College of Humanities and Social Sciences is one of Carnegie Mellon’s seven principal colleges. The college consists of the undergraduate program in Economics, and the departments of English, History, Modern Languages, Philosophy, Psychology, Social and Decision Sciences, Statistics, and an interdepartmental program in Information Systems. The college accounts for approximately one-fifth of the university’s undergraduate population; 85% of the college’s students are undergraduates. The college is staffed by 223 full-time faculty, and approximately 50 part-time faculty.

Like its counterparts in engineering, science, computer science, business, and the fine arts, the college has three primary and interrelated foci: undergraduate education, graduate education, and research or creative pursuits. Thus, the college shares in the university’s mission of merging first-rate, innovative research and creativity with undergraduate and graduate education. Since all faculty engage in both teaching and research or creative work, all Dietrich College undergraduates benefit from contact in the classroom with highly accomplished faculty researchers and artists.

Liberal/Professional Education

Edward Fiske, former Education Editor of The New York Times and author of the Fiske Guide to Colleges, long ago noted that the college and university have done “perhaps the most original thinking of any American university in pursuing the twin goals of liberal-professional education.” The college’s educational program is “liberal” in that it stresses breadth and invites wide-ranging inquiry, both through its general education curriculum and through programs in the humanities, behavioral sciences, and social sciences. The “professional” dimension of the college’s educational program derives from practical application of analytical and problem-solving skills and also from a subset of in-depth major programs which prepare students for specific career fields as well as for graduate or professional school. In its belief that these two types of knowledge (“liberal” and “professional”) are highly complementary, Dietrich College embraces a philosophy that has its roots in Carnegie Mellon’s institutional origins: namely, that the traditional liberal arts disciplines merit close, rigorous study, while practical skills are mastered.

The rationale for this liberal/professional approach stems from the premise that the intellectual foundations of a challenging liberal education and meaningful professional education are essentially the same. Knowledgeable and effective citizens are as much in need of broad intellectual perspectives, analytical skills, and problem-solving strategies as are most professionals. Moreover, as leaders in American higher education generally agree, undergraduate education is not well served if professional specialization in undergraduate programs is achieved prematurely. The challenge is to strike a balance between breadth and depth, both within and outside of one’s specialty. Such a balance insures versatility in one’s profession and the knowledge and ability to keep pace as individuals and citizens with changes in our social, technical, and cultural environments. Thus, the objectives of both liberal and professional education can and should work in tandem to complement and enhance one another.

Degree and Program Options

Dietrich College offers a wide range of innovative majors, and minors which provide a secondary focus to one’s primary area of study. In addition, there are a number of special programs which add breadth and enhance a student’s overall experience.

### Dietrich College Majors

<table>
<thead>
<tr>
<th>Department</th>
<th>Name of Major (Degree Options)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>Economics (B.A./B.S.)</td>
</tr>
<tr>
<td>English</td>
<td>English (B.A.)</td>
</tr>
<tr>
<td>English</td>
<td>Creative Writing (B.A.)</td>
</tr>
<tr>
<td>English</td>
<td>Professional Writing (B.A.)</td>
</tr>
<tr>
<td>English</td>
<td>Technical Writing and Communication (B.S.)</td>
</tr>
<tr>
<td>History</td>
<td>Global Studies (B.A.)</td>
</tr>
<tr>
<td>History</td>
<td>History (B.A.)</td>
</tr>
<tr>
<td>Interdepartmental*</td>
<td>Economics and Mathematical Sciences (B.S.) (by admission)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>Economics and Statistics (B.S.)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>Environmental Policy (additional major only)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>Ethics, History, and Public Policy (B.A./B.S.)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>European Studies (B.A.)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>Information Systems (B.S.) (by admission)</td>
</tr>
<tr>
<td>Interdepartmental**</td>
<td>Psychology and Biological Sciences (B.S.)</td>
</tr>
<tr>
<td>Interdepartmental</td>
<td>Student-Defined (B.A./B.S.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>Chinese Studies (B.A.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>French and Francophone Studies (B.A.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>German Studies (B.A.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>Hispanic Studies (B.A.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>Japanese Studies (B.A.)</td>
</tr>
<tr>
<td>Modern Languages</td>
<td>Russian Studies (B.A.)</td>
</tr>
<tr>
<td>Philosophy</td>
<td>Logic and Computation (B.S.)</td>
</tr>
<tr>
<td>Philosophy</td>
<td>Philosophy (B.A.)</td>
</tr>
<tr>
<td>Psychology</td>
<td>Cognitive Science (B.S.)</td>
</tr>
<tr>
<td>Psychology</td>
<td>Psychology (B.A./B.S.)</td>
</tr>
<tr>
<td>Social and Decision Sciences</td>
<td>Decision Science (B.S.)</td>
</tr>
<tr>
<td>Social and Decision Sciences</td>
<td>International Relations and Politics (B.S.)</td>
</tr>
<tr>
<td>Social and Decision Sciences</td>
<td>Policy and Management (B.S.)</td>
</tr>
<tr>
<td>Statistics</td>
<td>Statistics (B.S.)</td>
</tr>
</tbody>
</table>

### Notes:

* with the Department of Mathematical Sciences
** with the Department of Biological Sciences

### Additional Majors

Dietrich College students may pursue additional majors and/or minors in the college, and in other Carnegie Mellon colleges. An additional major refers to the completion of the requirements for a second major while also completing the requirements for the primary major and degree.

Most Dietrich College majors are also available as additional majors; one (Environmental Policy) is available only as an additional major. Students from outside Dietrich College can pursue available additional majors offered by the college, and would be required to complete only those courses in the college’s general education program that are prerequisites to courses required for the Dietrich College major in question.

### Minors

Minors are like majors in that they consist of coherent programs of study in a department, or across departments. Minors differ from majors in the number, breadth and depth of the courses required. Dietrich College students can also pursue minors offered and made available by other Carnegie Mellon colleges and departments.

There are two types of minors in the Dietrich College: departmental minors, which are housed in a Dietrich College academic department; and interdepartmental minors, which are sponsored by more than one department and administered through the faculty advisor’s academic department. The college’s minors are available to students from all colleges in the university.

<table>
<thead>
<tr>
<th>Department</th>
<th>Name of Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>Economics</td>
</tr>
<tr>
<td>Economics</td>
<td>Innovation, Economics, and Entrepreneur</td>
</tr>
</tbody>
</table>
Carnegie Mellon’s educational legacy emphasizes the connection between theoretical knowledge and practice. Similarly, the university’s interdisciplinary approach to education embraces the practical application and analysis of knowledge in institutional, social, historical, and global contexts. Carnegie Mellon graduates are excellent practitioners in their chosen fields. The Dietrich College general education program (hereafter referred to as the “GenEd program”) supports the development of that expertise and ensures that students gain well-informed perspectives and methodologies by providing the foundational knowledge required for in-depth study. Additionally, the GenEd program provides freshmen and sophomores—whether they have a specific interest, multiple interests, or are undecided about majors—with a systematic, intentional way of sampling the many options available in order to formulate, pursue, and achieve their academic goals.

Categories

To transcend narrow disciplinary boundaries, the GenEd program focuses on five broad intellectual activities that are exercised in nearly all disciplines: communicating, reflecting, modeling, deciding and creating. General subject areas associated with each activity are also indicated below. These activities form the bases for GenEd curriculum categories, in which suitable courses are included from all parts of the university.

The five categories are:
1. communicating (http://www.hss.cmu.edu/gened/gened-category.asp#Communicating): language and interpretations
2. reflecting (http://www.hss.cmu.edu/gened/gened-category.asp#Reflecting): societies and cultures
3. modeling (http://www.hss.cmu.edu/gened/gened-category.asp#Modeling): mathematics and experiments
4. deciding (http://www.hss.cmu.edu/gened/gened-category.asp#Deciding): social sciences and values
5. creating (http://www.hss.cmu.edu/gened/gened-category.asp#Creating): designs and productions

This framework highlights central features of an ideal learning environment and the university’s core intellectual mission.

Courses

1. Communicating: Language and Interpretations (18 units)

Courses in this category give special attention to the study of language as interpretation, expression and argument within and across multiple discourses. Students examine language for its internal logics and structures. They also explore its rhetorical, historical, cultural, or philosophical dimensions, assessing how it functions while expanding their writing skills and sharpening their analytical abilities.

<table>
<thead>
<tr>
<th>Required</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx One additional “communicating” course</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: Non-native English speakers may be placed into 76-100, instead of 76-101, Reading and Writing for an Academic Context (9 units), in their first semester. After successful completion of 76-100, they must take 76-101. For these students, these two courses will fulfill the GenEd “communicating” requirement category.

2. Reflecting: Societies and Cultures (18 units)

This category emphasizes the study of history, society, and culture from local and global perspectives. Courses investigate contemporary societies as well as those of the past, along with their rich array of cultural products, artifacts, and ideas. They encourage a comparative and reflective approach to the understanding of the past and what it can bring to the constitution of present social relations and cultural outlooks.

<table>
<thead>
<tr>
<th>Required</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-104 Global Histories</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx One additional “reflecting” course</td>
<td>9</td>
</tr>
</tbody>
</table>

3. Modeling: Mathematics and Experiments (27 units)

Courses in this category stress the interplay of mathematical (formal) theories and experimental work. Some courses investigate the internal structure of theories, whereas others use them as models for producing real-world knowledge. Such models may be drawn from a variety of disciplines including the natural sciences, but also such fields as psychology and computer science. The interactions between theorizing and experimenting (observing) can be understood within an intellectual framework that invites comparative assessment:

- mathematical sciences (complete a minimum of 9 units)
4. Deciding: Social Sciences and Values (18 units)

The theme of this category is the exploration of cognitive, behavioral, and ethical dimensions of decision-making on both the individual and social level. Making decisions requires a broad understanding of human rationality and social interaction. Some courses examine the critical collection and analysis of data for achieving such an understanding, whereas others emphasize the historical development of policies and values which form the matrix for decision-making.

Required Units

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>One additional “deciding” course</td>
<td></td>
</tr>
</tbody>
</table>

5. Creating: Designs and Productions (18 units)

In the arts, the humanities, the sciences, and in engineering, it is essential to produce artifacts: e.g., a painting, a poem, a musical performance, a piece of technology, the design of an experiment, or the proof of a mathematical theorem. Courses may center on the students’ creation of artifacts, but they may also analyze such creations by exploring creative processes at work within and across disciplines. Such explorations should be informed by a deep understanding of contexts of production and reception.

6. TWO Additional GenEd courses (18 units)

These courses are selected from any GenEd category.

7. University Requirement (UR) (3 units)

This course is a 3-unit mini-course, pass/no credit, completed in the first or second semester of the first year.

8. Freshman Seminar Requirement (FSR) (9 units)

This requirement ensures that all first-year students in the Dietrich College have a small-group course experience in their first year. Taught by selected members of the college’s faculty, these seminars enroll 15-17 students, are centered around topics based on faculty research and expertise, and are formatted to encourage a high level of student participation. For current seminar topics and course descriptions, visit the Dietrich College general education website. NOTE: The freshman seminar will not simultaneously fulfill any other requirement (e.g., in a major or minor requirement).

College Services and Programs

The educational programs in the Dietrich College are complemented by a number of services, special programs, centers, and computing facilities.

Dietrich College Academic Advisory Center

Gloria P. Hill, Assistant Dean and Director

Office: Baker Hall A57

http://www.cmu.edu/hss/ advisory-center/

The Dietrich College of Humanities and Social Sciences’ Academic Advisory Center (AAC) is primarily responsible for advising and monitoring the progress of students prior to deciding on a major. As the “home base” for undergraduates who are new to the college, the AAC provides an accessible, welcoming environment where students can seek information, advice, and counsel about selecting courses, the college’s general education program requirements, and the various majors and minors available. Just as important, advisors support students’ transition to the university and, through the advising process, all of the major dynamics of a student’s life. The advisor-student relationship is a reciprocal one. Advisors’ goals are to meet students where they are, to help them learn to successfully navigate the Carnegie Mellon environment, to become increasingly self-sufficient, and to make viable academic and personal decisions. This kind of relationship is vital to a student’s ability to progress, grow and thrive in a new and demanding educational environment.

The AAC is a walk-in center, although individual appointments may be made and are encouraged. The center’s hours are 8:30 a.m. to 5:00 p.m., Monday through Friday.

Globalization and International Politics

Academic Advisor: Emily Half, ehalf@andrew.cmu.edu, 412-268-7082, Baker Hall A60C

Faculty Director (IRP): Kiron K. Skinner, kskinner@andrew.cmu.edu, 412-268-3238, Porter Hall 223F

Faculty Director (GS): John Soluri, jsoluri@andrew.cmu.edu, 412-268-7122, Baker Hall 363

http://www.cmu.edu/lit/
Quantitative Social Science Scholars Program
Russell Golman, Director
Office: Porter Hall 223
http://www.hss.cmu.edu/qss/

The Quantitative Social Science Scholars Program (QSSS) offers unique opportunities in undergraduate education at Carnegie Mellon. In recent years, advances in computing power, increasingly powerful models of human behavior, and the exponential growth of data sets recording human economic and social activity have created new opportunities for entrepreneurs, policymakers, and scholars seeking insight into human social behavior. Firms throughout the economy can now use data analytics to identify new markets, avoid errors, and improve efficiency. Policymakers can use the same techniques to shape the direction and expand the impact of social policies designed to promote the public good. Social scientists can also use these techniques to create a broader and deeper scientific understanding of human behavior that serves as the foundation upon which both entrepreneurs and policymakers can build.

The QSSS program is designed to help outstanding undergraduates impact society through data-driven research and data science. It does so by building a structured program of training in advanced quantitative techniques that can be broadly applied across a range of social science disciplines and topics. Students combine this methodological training with more traditional coursework in the social science major of their choice. The program equips students to undertake sophisticated analysis of their own, and features an integrative senior thesis project that applies their methodological training to a research question of their own choosing.

The QSSS program is not a freestanding major or a minor, per se. It is a program designed to be taken in conjunction with a social science major in Dietrich College but open, in principle, to students majoring in other programs. The program explicitly seeks to recruit students from a range of disciplines and create a cohesive interdisciplinary learning community among its students. Majors that could fit well with this program include (but are not limited to) economics, decision science, policy and management, international relations and politics, and statistics.

Special features of the QSSS program include:
- An optional residential component that allows QSSS students to live together in their first year
- A common freshman seminar that emphasizes QSSS topics (this seminar fulfills the Dietrich College freshman seminar requirement)
- A core curriculum in five segments: mathematical and statistical foundations, social science modeling, regression analysis of large data sets, data collection and generation, and computational data methods.
- A required senior thesis under the dual supervision of a QSSS-affiliated faculty member and a faculty advisor from the student’s home department.
- A QSSS seminar series that invites speakers to campus to help students in the program see how the skills they are developing are applied both in research and in practice.

Science and Humanities Scholars Program
William Alba, Director
Office: Doherty Hall 2201
http://www.cmu.edu/shs/

The Science and Humanities Scholars Program (SHS) is designed to enable talented students to develop and pursue an undergraduate program that builds upon their interests and achievements in the humanities, natural sciences, mathematics, or social sciences. The program is based on a special general education core that provides an academic foundation from which students can select a major in either the Dietrich College of Humanities and Social Sciences or the Mellon College of Science.

Features of the SHS program include:
- Equal access to courses in both MCS and Dietrich College
- An optional residential program that allows a group of SHS first-year students to live together in a dormitory cluster
- Opportunities to collaborate with faculty in cutting-edge interdisciplinary research
- A broad selection of freshman seminars led by distinguished faculty from across the two colleges

Selected students admitted to Dietrich College and/or MCS are invited to join the SHS program at the same time that they receive their notification of admission to the university. Those accepting are advised by the SHS program director until they declare a major.

Student-Defined Program
Joseph E. Devine, Director; Associate Dean for Undergraduate Studies
Office: Baker Hall 154
http://www.cmu.edu/shs/sdm

For students whose educational goals cannot be as adequately served by the curricula of existing programs, the college provides the opportunity to self-define a major or minor. The procedure for establishing such a major centers on a written proposal, submitted to the college dean’s office. This proposal consists of two parts:

Major description and rationale: A description of the components of the proposed program of study; a presentation of the objectives of the program of study, why it represents a coherent and (given available faculty, courses, and other resources) viable course of study, and the reason(s) why these objectives cannot be accomplished within one or more of the college’s existing programs.

The curriculum: Presentation of a complete outline of all courses that will comprise the requirements for the major, categorized according to that component of the major program to which each belongs (e.g., mathematics, prerequisites; research methods; theoretical perspectives; etc.), and second, a semester-by-semester outline that indicates when each course is to be taken (or, for any already taken, when taken and grade received). The minimum requirement for graduation is, as with all majors in the college, 360 units of credit.

Proposals and curricula are evaluated for clarity of focus, coherence and depth in related areas, and viability within the context of the college and university. Proposals should generally be developed no later than the sophomore year, and approved majors begin their program generally no later than the junior year.

Study Abroad Scholarships
http://www.hss.cmu.edu/departments/deans_office/studyabroad/scholarships_studyabroad.html

The Dietrich College Dean’s Office offers the following scholarships to encourage and support study abroad.

The Abel M. Bomberault Study Abroad Fellowship
This fellowship is given in memory of Abel M. Bomberault (class of 1956). Multiple scholarships of up to $2,000 are awarded to Dietrich College, BHA, or SHS students for a semester, a full year, or summer study in a French-speaking country, with preference for France. Majors and minors in French are given preference.

The Brona Stein Buerger Scholarship
These annual scholarships provide funds for up to two Dietrich College, BHA or SHS students, from any class or major, to be used toward a semester or full year of study in an accredited program of education abroad. Current sophomores and juniors receive preference. This award has been given in memory of Brona Stein Buerger, Margaret Morrison class of 1962.

The Hannah Estermann Bergman Study Abroad Fund
This annual scholarship provides funds for one Dietrich College student who is currently studying Spanish. Preference is given to sophomores and juniors who are modern languages majors. This award has been given in memory of Hannah Estermann Bergman, Margaret Morrison class of 1946.

Dietrich College Summer Internship Opportunity Grants
http://www.hss.cmu.edu/

Dietrich College encourages students to pursue interesting and professionally relevant internship opportunities for summer employment. Often the very positions that provide students with first-rate, challenging work experiences are unpaid or provide minimal pay. To help compensate students for taking on work experiences that will be invaluable in helping them define and move toward their career goals, the Dietrich College Summer Internship Opportunity Grants Program seeks to make it more possible for students to take advantage of unpaid but worthwhile internship opportunities with grants of up to $2,000.

Undergraduates with primary majors in Dietrich College, BHA and SHS and strong academic records are eligible and encouraged to apply. Current sophomores and juniors receive preference. NOTE: Graduating seniors are not eligible.

Students are expected to find their own internships. There are many resources available to help in finding internships, including the university’s Career and Professional Development Center’s TartanTrak database. Preference for grants is given to students who find positions in government or non-profit agencies.

Washington Semester Program
Kiron Skinner, Faculty Director; kskinner@andrew.cmu.edu
Emily Half, Academic Advisor; ehall@andrew.cmu.edu; 412-268-7082, Baker Hall A60C
From embassy headquarters to non-governmental organizations, think tanks to advocacy organizations, and consulting firms to media outlets, Washington, DC, is a focal point for many international and public policy activities.

Undergraduates from any course of study who would value firsthand policy experience are invited to apply to Carnegie Mellon University's Washington Semester Program, sponsored by the university's Center for International Relations and Politics. In this semester-long program, students live, work, and study in Washington, DC, coming into direct contact with political, business, and community leaders and learning about the most pressing policy issues of the day.

The Center for International Relations and Politics sponsors policy events and forums in Washington for CMU students participating in the program to further enrich their experience and enhance their understanding of how Washington functions as a hub of international and public policy decision making.

Students should contact the academic advisor for more information or to discuss how the CMUWSP may fit into their curriculum.

Academic Standards, Regulations and Protocols

Transferring into the Dietrich College

Undergraduate students in other Carnegie Mellon colleges who wish to transfer (http://www.cmu.edu/hs/advisory-center/transferring/transferring.html) to the college apply through the Dietrich College of Humanities and Social Sciences’ Academic Advisory Center in Baker Hall A57. If approved, the transfer is into the college first and then, when appropriate, into a primary major. Decisions regarding transfer requests will be based on evidence of adequate prior academic performance and on the applicant’s prospects for success in the major requested. Students interested in transferring into the college should begin the process well before the registration period for the semester. Applications for transfer and will not be accepted the two weeks prior to the registration period and registration week of each semester. The earliest point when undergraduates are considered for transfer into Dietrich College is the second semester of the first year.

Academic Actions

In order to maintain good academic standing, Dietrich College students must attain at least minimum quality point averages for each semester (as well as cumulatively) and also maintain adequate progress toward completing graduation requirements. Minimum quality point averages for good academic standing are 1.75 in the freshman year and 2.00 thereafter. “Adequate progress towards graduation” generally means that students are successfully completing 45-49 units per semester so that at the end of eight semesters they had accumulated the 360 units required for graduation.

When a student fails to meet minimum performance criteria, it normally results in an “academic action.” Depending on the circumstances, one of these actions is taken: academic probation, continue probation, suspension, or drop. These academic actions are recommended by the college’s departments based on the guidelines below. However, the sequence of the academic actions is not automatic in all cases. In exceptional cases, certain actions may be skipped. Decisions may be based on individual student performance and extreme circumstances, and are not determined purely by quality point averages.

Probation

A student is placed on academic probation when performance either for the semester or cumulatively fails to meet the minimum standard. The term of academic probation is one semester, and signifies to the student the college’s insistence that academic performance return to at least the minimum acceptable level. A student is removed from academic probation and returned to good academic standing when both the semester and cumulative quality point averages meet at least the stated minimums. A student who has had one semester on probation and is not yet meeting minimum requirements but is making significant progress may be continued on probation.

Suspension

Academic suspension is the usual action taken when a student fails to meet the minimum semester or cumulative requirements for two consecutive semesters. In general, a freshman will be suspended if the semester and overall QPA are below 1.75; for sophomores, juniors, and seniors, if these are below 2.00. Failure to maintain adequate progress toward graduation may also be a contributing factor in such decisions.

The minimum period of academic suspension is normally two semesters. At the end of that period, a student may seek readmission through the Assistant Dean’s office. In order to receive approval to return, the student must do the following: formally request approval to return in writing, describing in detail the relevant activities pursued during the academic suspension period; complete the Petition to Return From Leave of Absence form; provide transcripts from other colleges and universities if courses have been taken while on suspension; provide evidence of satisfactory on-the-job performance if the student has worked while on academic suspension; and furnish the names, addresses, phone numbers and email addresses of three individuals with whom he or she has worked or studied, to whom the college will write to request a letter of reference on the student’s behalf. Once the return petition is complete, the student’s advisor is asked to review it and submit a recommendation to the Assistant Dean along with any conditions to be imposed.

Once cleared to return from academic suspension, Enrollment Services will be notified and the student will be eligible to enroll. While on academic suspension, students are considered to be on a mandatory “leave of absence”, and are governed by college and university policies concerning leaves of absence and withdrawals. See subsequent discussions of “Leave of Absence and Withdrawal from the College.” Students returning from academic suspension do so on final academic probation.

Drop

The most severe academic action occurs when a student is dropped from the college and the University, and is not permitted to enroll again. This normally results when a student, already on final academic probation, continues to perform at levels below the minimum set by the college for good academic standing, and shows no indication of being able to reach an acceptable level of performance or maintain steady progress toward completing graduation requirements. It is also an option where, in unusual cases, a student has performed extremely poorly, and been unresponsive to outreach efforts.

Dietrich College Dean’s Honor List

Each semester the college recognizes those students who have attained outstanding semester quality point averages by naming them to the HGSS dean’s honor list. To be eligible, students must have no conditional grades (i.e., “[Incomplete]” or “X” [“Conditional Failure”]) at the time when final semester grades are recorded.

Students who complete at least 45 factorable units and attain a semester GPA from 3.50 through 3.74 are named to the Dean’s List, with Honors; if the semester GPA is 3.75 or higher, students are named to the Dean’s List, with High Honors.

Students who complete at least 36 or up to 44 factorable units and attain a semester GPA of 3.75 or higher are named to the Dean’s List, with Honors.

Course Overloads

Overloading is defined as taking more than the equivalent of five full-semester courses in one semester, and for Dietrich College students it usually means registering for more than 50 units in one semester. Eligibility to overload is defined as having a GPA of 3.00 (or higher) in the last completed semester and a current cumulative GPA of at least 3.00. Students new to the college and university (i.e., first-year students and new external transfer students) may not overload during their first Carnegie Mellon semester. Eligibility does not automatically allow the student to register for an overload. Rather, eligible students must complete an overload petition, and meet with their primary academic advisor to discuss overloading. If approved, the academic advisor will increase the student’s unit maximum in the student record system.

The first opportunity to register for a course overload is after registration week for the proposed overload semester. Registration week for the spring semester is usually the third week in November; for the fall semester, it is usually the third week in April. Consult the official academic calendar for the exact dates.

If as a result of final grades for the current semester a student approved to overload for the next semester falls below the QPA overload eligibility criteria, the academic advisor may withdraw the overload permission. Students affected are responsible for resolving this in consultation with their academic advisor.

Physical Education, StuCo and Military Science Courses

A maximum of nine units of credit for any combination of physical education (69-xxx), StuCo (98-xxx) and all military science courses (30-xxx, 31-xxx, 32-xxx) may be counted for credit toward graduation. Physical education, StuCo and military science courses are not included when calculating
a student’s QPA or when calculating units to determine eligibility to "overload."* 

* StuCo (http://www.cmu.edu/stuco) refers to “student led courses” — i.e., courses designed by students, and approved to be offered for academic credit.

Course Failures and Course Repetitions

Students who fail a required course must repeat and pass it (or take and successfully complete another approved course that fulfills the requirement). If a failed course is a prerequisite to more advanced course work within a particular course sequence, the failed course must in general be repeated before moving on to the higher level course. Exception: Dietrich College freshman seminars may not be repeated, or replaced by a second seminar.

Failed courses that are repeated and passed, or courses that are passed but repeated in order to obtain a higher grade, are not replaced on the student’s record. Both course grades remain on the record, and are included in calculating the student’s QPA. Students who repeat a course that they have already passed will not be able to apply the second set of units for the course toward graduation requirements.

Internships-for-Credit

An internship-for-credit is a supervised, professional work experience with clear links to a student’s academic program performed primarily or totally outside a regular course structure, and for which a student earns academic credit. Students doing an internship for academic credit must be registered through the academic department of the faculty member supervising the internship, and must register for the internship course during the term (including the summer) when the internship work is being performed. There is no additional tuition charge for internships that are taken during the academic year. Students registered for internships during the summer will be billed for tuition at the per-unit rate set by the university.

To receive academic credit, the internship:

- requires the involvement of a Carnegie Mellon faculty sponsor and an on-site supervisor in the internship, design and evaluation;
- may include regular or periodic meetings between the student, the faculty sponsor, and/or the internship site supervisor to monitor progress;
- requires an end-product for submission to the faculty sponsor. This usually takes the form of a paper, but may also include a presentation, or some other approved form;
- can be taken for a regular letter grade by registering for the internship course through the sponsoring department. With department approval, the grade may be counted for graduation requirements.

Policies and practices regarding internships-for-credit vary among departments. Departments are not obligated to allow such credit for its majors, and are free to determine whether an internship may be used to fulfill requirements or electives. An internship-for-credit is a graded experience. Each department will determine appropriate criteria for the grade if an internship is approved for credit.

Credits are earned according to the following scale: 9 units = the equivalent of 1 day (9-12 hours) per week during a semester (100 hours), 18 units = the equivalent of 2 days (12-24 hours) per week during a semester (200 hours). A Dietrich College student may not earn more than 18 units of internship credit during a semester or count more than 27 units of internship credit toward graduation requirements.

When the internship sponsor requires that a student receive academic credit from the home institution, the student should contact the Dietrich College Associate Dean for Undergraduate Studies for information and advice about options.

Dietrich College Credit Policy for Non-Carnegie Mellon Courses

The following policy governs the practice of Dietrich College undergraduates taking courses elsewhere and requesting that credits for these courses transfer to their Carnegie Mellon University academic record. Courses taken elsewhere will be considered for transfer credit if the institution offering them is fully accredited, and if the courses in question are judged to be acceptable for the purposes proposed by the student.

Limits

Once a student enrolls in the university as a degree candidate, he or she may take a maximum of five courses (or their rough unit equivalent) elsewhere and transfer these back for credit toward their Carnegie Mellon degree. No courses may be transferred and be substituted for the following general education requirements:

- 76-101 Interpretation and Argument or 76-100 Reading and Writing for an Academic Context
- 79-104 Global Histories
- 36-201 Statistical Reasoning and Practice
- 99-101 Computing @ Carnegie Mellon or 99-102 Computing @ Carnegie Mellon
- Freshman Seminar requirement

In addition, no more than two courses from another institution may be counted for Dietrich College general education requirements; no more than one course from another institution may count in any one general education category (e.g., “communicating,” “reflecting,” etc.)

Exceptions

These limits do not apply to courses and credits approved through Advanced Placement examinations, International Baccalaureate examinations, cross-registration through the Pittsburgh Consortium for Higher Education (PCHE), Washington Semester program, and approved study abroad or exchange programs. Exceptions to these restrictions may be made only by way of written petition to the Dietrich College Council (c/o the Dietrich College Academic Advisory Center).

Grades

Courses taken elsewhere must be taken for a regular letter grade (not pass/no credit). Students must earn a final grade of at least "C" in order for the credit to transfer. A "C-" grade is not transferable when its equivalency is below a 2.00 on a 4.00 scale, or 70%. Only units, not grades, transfer for courses taken elsewhere, and thus do not affect a student’s Carnegie Mellon QPA.

External Transfer Students

For students entering Carnegie Mellon and Dietrich College as external transfers, the same five-course limit applies after they become Carnegie Mellon degree candidates, unless their transfer credits reach the 180 unit limit for transfer credit stipulated by university policy. A candidate for the bachelor’s degree must complete at the university a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of coursework. If a degree has already been obtained at another institution, courses that count toward that degree may not be used again as transfer credit toward a Carnegie Mellon University undergraduate degree.

Internal Transfer Students

This policy applies retroactively to students who enter Dietrich College through internal transfer, and counts courses previously approved for transfer credit. These courses will be re-evaluated for consistency.

Students on Academic Suspension

Subject to the college’s policy limiting transfer course credit, students on academic suspension from Dietrich College will be permitted to receive credit for no more than three courses per semester taken elsewhere, and no more than a total of five courses elsewhere, while on suspension. Approval to take these courses for credit is to be obtained in advance.

While on academic suspension, students are considered to be on a mandatory “leave of absence” and are governed by College and University policies concerning leaves of absence and withdrawals (http://www.cmu.edu/hub/registration/leave.html).

Dietrich College Department Limits

Dietrich College academic departments may not exceed these college limits, but may impose stricter limits regarding courses that students propose to take elsewhere to fulfill major requirements.

Double-Counting Courses

Double-counting refers to instances when a course taken to fulfill one requirement counts simultaneously toward a requirement in another major or minor program. While the college encourages study in complementary areas where majors and minors frequently share common requirements, it also wants to keep clear the meaning and integrity of the labels “major” and “minor.” To preserve the integrity of these definitions, double-counting is permitted in Dietrich College on a very limited basis, and only in those instances when the course(s) in question represent only a small portion of the second program.

The college and its departments have developed program-specific guidelines for this practice that appear throughout the Dietrich College section of this catalog, and particularly in the case of major and minor programs that students frequently pursue in combination.
Graduation Requirements

Eligibility for graduation in Dietrich College requires that a student:
1. complete all general education requirements,
2. complete all course requirements in a primary major,
3. achieve a cumulative quality point average of at least 2.00 for all courses taken (or, alternatively, for all courses taken after the 1st year),
4. earn at least 360 units with a minimum of 180 units taken at Carnegie Mellon University,
5. be recommended (certified) by the faculty of the primary major in the college,
6. meet all financial obligations to the university, and
7. qualify for graduation within eight years of the date on which the degree is granted.

The college reserves the right to modify these academic standards, actions, and regulations.

Graduation with University Honors
Dietrich College students who achieve an overall QPA of at least 3.50 (by the end of the 7th semester) will be recommended for graduation with university honors.

Graduation with College Honors
Students who successfully complete a senior honors thesis under the auspices of the Dietrich College senior honors program qualify for graduation with Dietrich College honors.
Dietrich College Interdepartmental Majors

When addressing complex issues, we often rely on approaches that take advantage of a variety of relevant disciplines. The college houses the special category of "interdepartmental majors" for programs where this interdisciplinary approach is most pronounced and in which the varied disciplinary perspectives are most fully integrated. These majors are presented here separately, rather than as departmentally-based options, to reflect and underscore their sponsorship by more than one academic department and the unique features that follow from this structure.

Interdepartmental majors are administered by the academic department of the major's faculty advisor.

The Major in Economics and Mathematical Sciences

Faculty Advisor: Carol Goldberg
Office: GSIA 133
Email: cg28@andrew.cmu.edu

The B.S. in Economics and Mathematical Sciences (http://coursecatalog.web.cmu.edu/collegeofhumanitiesandsocialsciences/undergraduateeconomicsprogram/#bseconomicsandmathematicalsciencescurriculum) is a collaborative effort between the Department of Mathematical Sciences and the Undergraduate Economics Program. Combining advanced mathematics with advanced economic theory is the hallmark of this curriculum. The curriculum provides students with courses that complement and develop depth of understanding of economic theory, applied economics, and applied mathematics. This major offers an integrated curriculum, guiding students through a program of coursework that exploits and builds upon the synergies between mathematics and economics. This degree program equips students with the mathematical tools that are essential for success in Ph.D. programs in economics; mathematics; and key functional areas of business including finance, accounting, marketing, and information systems. Students pursuing this degree will be well prepared for the beginning of their research careers in academia, government, and industry. There are a limited number of student slots in this program; interested students may apply as early as their sophomore year.

The curriculum requirements for the B.S. in Economics and Mathematical Sciences can be viewed at: http://coursecatalog.web.cmu.edu/collegeofhumanitiesandsocialsciences/undergraduateeconomicsprogram/#bseconomicsandmathematicalsciencescurriculum

The Major in Economics and Statistics

Faculty Advisor: Rebecca Nugent
Office: Baker Hall 132A
Email: acadcoord@stat.cmu.edu

The major in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major’s curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major learn to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

B.S. in Economics and Statistics Curriculum

Mathematics Requirements (39 Units)

Units
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations and Approximation 10
21-241 Matrices and Linear Transformations 10
21-259 Calculus in Three Dimensions 9 or 21-256 Multivariate Analysis

Writing Requirement (9 Units)

Units
73-270 Writing for Economists 9

Disciplinary Core - Economics (48 Units)

Units
73-100 Principles of Economics 9
73-150 Intermediate Microeconomics 9
73-200 Intermediate Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6
73-261 Econometrics 9

Disciplinary Core - Statistics (45 Units)

Units
36-202 Statistical Methods 9 or 36-309 Experimental Design for Behavioral and Social Sciences
or 70-208 Regression Analysis
36-225 Introduction to Probability Theory 9 or 36-217 Probability Theory and Random Processes
or 21-325 Probability
36-226 Introduction to Statistical Inference 9
36-401 Modern Regression 9
36-402 Advanced Data Analysis 9

Advanced Electives (45 Units)

Students must take five advanced elective courses with a minimum of two from the Undergraduate Economics Program and two from the Department of Statistics. Advanced elective courses are those numbered 73-300 through 73-495. For the purpose of these requirements, the Undergraduate Economics Program may also designate as advanced electives courses from other departments. The Department of Statistics designates advanced electives as those courses number 36-300 and higher.

Sample Course Schedule for the B.S. in Economics and Statistics

First Year

Fall Term Units
xx-xxx Freshman Seminar 9
21-120 Differential and Integral Calculus 10
36-201 Statistical Reasoning and Practice 9
73-100 Principles of Economics 9
99-101 Computing @ Carnegie Mellon 3
xx-xxx Open 9
49

Spring Term Units
21-259 Calculus in Three Dimensions 9
73-150 Intermediate Microeconomics 9
76-101 Interpretation and Argument 9
79-104 Global Histories 9
xx-xxx Open 9
45

Second Year

Fall Term Units
21-122 Integration, Differential Equations and Approximation 10
36-225 Introduction to Probability Theory 9
73-200 Intermediate Macroeconomics 9
73-450 Economics Colloquium 1
xx-xxx Open 9
xx-xxx Open 9
47

Spring Term Units
21-241 Matrices and Linear Transformations 10
36-226 Introduction to Statistical Inference 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6
73-270 Writing for Economists 9
xx-xxx Open 9
49

Third Year

Fall Term Units
73-261 Econometrics 9
36-401 Modern Regression 9
xx-xxx Advanced Economics Elective 9
xx-xxx Statistics Elective 9
xx-xxx Open 9
45
Additional Major in Environmental Policy

Peter Madsen, Faculty Director
Office: Hamburg Hall 210BA
Email: pm2@andrew.cmu.edu

The major in Environmental Policy (which is only offered as an additional major) focuses attention on the interaction of humans with the environment from a multitude of perspectives. Human activities have had and continue to have large-scale and long-term consequences for environmental quality. Environmental quality relates to the quality of our daily lives, to our physical health, and to the future vitality and even survival of human society. The Additional Major in Environmental Policy is designed to provide students with the interdisciplinary background and skills necessary to understand environmental issues. It emphasizes three general areas: (1) humanities and the arts; (2) social sciences; and (3) natural science and technology. The humanities emphasis concerns the ethical, legal, and historical basis of environmental concerns as well as their aesthetic manifestations. The social science area concentrates on the economic and political nature of environmental problems and possible policy options and responses. The natural science and technology focus includes the exploration of ecology as well as the role of technology as both problem creator and problem solver.

The Environmental Policy major is open to all Carnegie Mellon students as an additional major. It is administered by an interdepartmental committee, with Peter Madsen, of the Vice Provost for Education Office, as principal advisor. The major features training in relevant research methods; a set of core courses on environmental issues from several disciplinary vantage points; an elective; and a project course experience.

Prerequisites 54–56 units

Two courses in Calculus:
21-111-21-112 Calculus I and Calculus II or equivalent

Two courses in Statistics:
36-201-36-202 Statistical Reasoning and Practice and Statistical Methods or equivalent

One of the following groups:
Two courses in Biology:
03-121-03-122 Modern Biology and Organismic Botany
or
03-121 & 03-122 Modern Biology and Modern Biology Laboratory

Two courses in Chemistry:
09-103-09-104 Atoms, Molecules and Chemical Change and Fundamental Aspects of Organic Chemistry and Biochemistry
Introduction to Modern Chemistry I and Modern Chemistry II
or
09-105 & 09-106 The following two courses:
09-100-09-103 Introduction to Chemical Engineering and Atoms, Molecules and Chemical Change

The following course is recommended, although not required: 73-100 Principles of Economics.

Research and Analytical Methods 18–21 units

Required Electives 9–12 units

Complete one course in one of the following areas:

Science and Technology
09-510 Introduction to Green Chemistry
12-351 Introduction to Civil and Environmental Engineering
12-651 Air Quality Engineering
19-101 Introduction to Engineering and Public Policy
19-448 Science, Technology & Ethics
19-450 Climate and Energy Science, Economics and Public Policy
24-424 Energy and the Environment
88-391 Technology and Economic Growth

* particularly extensive prerequisites; not to be taken by students whose primary major is in CIT

(Additional courses may be approved in consultation with the advisor.)

Humanities
76-319 Environmental Rhetoric
76-395 Science Writing
76-476 Rhetoric of Science
79-372 Perspectives on the Urban Environment
79-374 American Environmental History: Critical Issues
79-375 China’s Environmental Crisis
79-377 Food, Culture, and Power: A History of Eating
79-381 Energy, Environment, Globalization in the Americas
80-244 Environmental Ethics

(Social Sciences
73-148 Environmental Economics
88-223 Decision Analysis and Decision Support Systems
89-302 Behavioral Decision Making
90-765 Cities, Technology and the Environment
90-798 Environmental Policy & Planning
90-808 Energy Policy

(Additional courses may be approved in consultation with the advisor.)

Economics
19-451 EPP Projects (pre-approved sections)
19-452 EPP Projects (pre-approved sections)
88-220 Policy Analysis I (pre-approved sections)
88-221 Policy Analysis II (pre-approved sections)

The Major in Ethics, History, and Public Policy

Faculty Advisor: Jay Aronson
Office: Baker Hall 246B, 412/268-2887
Email: aronson@andrew.cmu.edu.

The B.A./B.S. in Ethics, History, and Public Policy is an interdepartmental major offered jointly by the Departments of History and Philosophy. It prepares students for leadership positions in law, public policy, ethics, and advocacy by providing them with a rigorous, interdisciplinary humanistic and social-scientific education. It also serves as an excellent spring board
for graduate study in a wide variety of disciplines. The program focuses equally on the historical understanding of how modern-day problems have evolved, and the importance of developing clear criteria for ethical decision-making. The capstone project course provides students with the opportunity to engage with real-world public policy challenges using the methods, theories and knowledge that they have gained through the major. Offered jointly by the departments of History and Philosophy, the B.A./B.S. in EHPP encourages specialization, internship experiences, and research in a wide range of policy areas.

Curriculum

Students graduating with a primary major in Ethics, History, and Public Policy may elect to receive either a Bachelor of Arts or a Bachelor of Science Degree (additional requirements apply; see below). Basic requirements include 123 units encompassing 9 units in Economics, 39 units in History, 36 units in Philosophy, 27 units of elective courses, and a 12-unit, senior capstone course. This program may also be taken as an additional (e.g., second) major.

I. Economics Requirement 9 units
Choose one of the following:
73-100 Principles of Economics 9
88-220 Policy Analysis 9

II. History Core 39 units
Choose one 9-unit course from each category below:
Policy History (9 units)
79-300 History of American Public Policy 9
U.S. History (9 units)
79-240 The Development of American Culture 9
79-249 20th Century U.S. 9
Non-U.S. History (9 units)
79-205 20th Century Europe 9
79-207 Development of European Culture 9
79-220 Caribbean: Cultures and Histories 9
79-222 Between Revolutions: The Development of Modern Latin America 9
79-226 Introduction to African History: Earliest Times to 1780 9
79-227 Introduction to African History: 1780-1984 9
79-307 Religion and Politics in the Middle East 9
79-261 Chinese Culture and Society 9
79-265 Russian History: From the First to the Last Tsar 9
79-266 Russian History: From Communism to Capitalism 9

III. Philosophy Core 36 units
Choose one 9-unit course from each category below. No more than 18 units at the 100 level may be counted toward this requirement.
Ethics (9 units)
80-130 Introduction to Ethics 9
80-230 Ethical Theory 9
Political Philosophy (9 units)
80-335 Introduction to Political Philosophy 9
80-235 Political Philosophy 9
Foundations of Social Science (9 units)
80-221 Philosophy of Social Science 9
80-321 Causation, Law, and Social Policy 9
80-337 Philosophy Politics & Economics 9

Applied Philosophy (9 units)
80-236 Social Structure, Public Policy & Ethics 9
80-241 Ethical Judgments in Professional Life 9
80-244 Environmental Ethics 9
80-245 Medical Ethics 9
80-247 Ethics and Global Economics 9
80-341 Computers, Society and Ethics 9
80-344 Management, Environment, and Ethics 9
80-348 Health Development and Human Rights 9
80-447 Global Justice 9

IV. Senior Capstone Project Course (79/80-449) 12 units
The Ethics, History and Public Policy Project Course is required for the Ethics, History and Public Policy major and is taken in the fall semester of the senior year. In this capstone course, Ethics, History and Public Policy majors carry out a collaborative research project that examines a compelling current policy issue that can be illuminated with historical research and philosophical and policy analysis. The students develop an original research report based on both archival and contemporary policy analysis and they present their results to a client organization in the community.

V. Elective Courses 27 units
Choose any three courses from any category or categories shown below.

Business
70-311 Organizational Behavior 9
70-321 Negotiation and Conflict Resolution 9
70-322 Business, Society and Ethics 9
70-364 Business Law 9
70-365 International Trade and International Law 9
70-430 International Management 9

Economics (some courses have prerequisites; see Economics catalog listing)
73-148 Environmental Economics 9
73-310 Evolution: Economic Ideas and Analysis 9
73-351 Public Finance 9
73-357 Regulation: Theory and Policy 9
73-358 Economics of the Environment and Natural Resources 9
73-359 Benefit-Cost Analysis 9
73-365 Firms, Market Structures, and Strategy 9
73-371 International Trade and Economic Development 9
73-372 International Money and Finance 9
73-375 History of Money and Monetary Policy 9
73-408 Law and Economics 9
73-476 American Economic History 9

English
76-492 Rhetoric of Public Policy 9

History
Courses from the EHPP History Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.
79-221 Development and Democracy in Latin America 9
79-231 American Foreign Policy 1945-Present 9
79-233 The United States and the Middle East since 1945 9
79-242 Topics in African American History: Reconstruction to the Present 9
79-267 The Soviet Union in World War II: Military, Political and Social History 9
79-303 Pittsburgh and the Transformation of Modern Urban America 9
79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967 9
79-306 Delinquency, Crime, and Juvenile Justice: 1970s to the Present 9
79-320 Women, Politics, and Protest 9
79-331 Body Politics: Women and Health in America 9
79-333 Biology and Society: Evolution Animal Experimentation and Eugenics 9
79-334 Law, Ethics, and the Life Sciences 9
79-335 Drug Use and Drug Policy 9
79-338 Education and Social Reform 9
79-339 Juvenile Delinquency Through Film 9
79-342 Introduction to Science and Technology Studies 9
79-359 Sustainable Innovations: Ideas, Policies & Technologies to Make a Better Planet 9
79-368 Poverty, Charity, and Welfare 9
79-371 African American Urban History 9
79-374 American Environmental History: Critical Issues 9
79-381 Energy, Environment, Globalization in the Americas 9
79-383 Epidemic Disease and Public Health 9
79-389 Stalin and Stalinism 9

Philosophy
Courses from the EHPP Philosophy Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.
80-305 Rational Choice 9
80-405 Game Theory 9
80-241 Ethical Judgments in Professional Life 9
80-256 Modern Moral Philosophy 9
80-341 Computers, Society and Ethics 9
80-344 Management, Environment, and Ethics 9

Social and Decision Sciences
88-104 Decision Processes in American Political Institutions 9
88-181 Topics in Law 1st Amendment 9
88-223 Decision Analysis and Decision Support Systems 9
88-343 Economics of Technological Change 9
Additional Major

The B.A./B.S. in Ethics History and Public Policy may be scheduled as an additional major in consultation with the departments concerned.

Ethics, History, and Public Policy Sample Curriculum

Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th></th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core requirement in History or Philosophy</td>
<td></td>
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<tr>
<td>Core requirement in History or Philosophy</td>
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<td>Core requirement in History or Philosophy</td>
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<tr>
<td>Core requirement in History or Philosophy</td>
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<td>Core requirement in History or Philosophy</td>
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<tr>
<td>Core requirement in History or Philosophy</td>
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<td>Core requirement in History or Philosophy</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior Year</th>
<th></th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>Capstone Course</td>
<td>EHPP Elective Course</td>
<td></td>
</tr>
<tr>
<td>EHPP Elective Course</td>
<td>Non-EHPP Course as Needed</td>
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</tr>
<tr>
<td>EHPP Elective Course</td>
<td>Non-EHPP Course as Needed</td>
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</tr>
<tr>
<td>Non-EHPP Course as Needed</td>
<td>Non-EHPP Course as Needed</td>
<td></td>
</tr>
</tbody>
</table>

The above sample program is presented as a two-year (junior-senior year) plan for completing EHPP major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter the EHPP major, and begin major course requirements, as early as the start of the sophomore year, or even in the first year. Students should consult their advisor when planning their program.

The Major in European Studies

Advisors: Kenya C. Dworkin (Hispanic Studies), Chris Hallstein (German), or Bonnie Youngs (French & Francophone Studies)

Offered jointly by Modern Languages and History, the major in European Studies is a unique interdisciplinary program that seeks to develop and enhance students’ understanding of European societies and cultures. It aims to train students in literature and language, cultural history and the arts, as well as related areas of professional opportunity. It offers students substantive knowledge of Western European society through two approaches. First, it provides a foundation in one of the continental Western European languages. Second, it encourages comparative inquiry across boundaries of time, nation, and scholarly discipline.

Curriculum

Offered jointly by the Departments of Modern Languages and History, the European Studies major leads to a B.A. degree.

European Studies majors must take two prerequisite courses (18 units) in one foreign language (French, Spanish, or German) or demonstrate the equivalent in language ability through the Carnegie Mellon Language Placement Test. The requirements include a minimum of 99 units divided into core courses (63 units) and electives (36 units). Students are strongly advised to fulfill prerequisite and core courses by the end of their junior year. Students are encouraged to take advantage of the Study Abroad Program.

Students are urged to check with the Major Advisor in selecting courses for this major.

Major Requirements 99 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high AP or CEEB scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. Progress toward the major will be accelerated by study abroad.

1. Core Courses in Modern Languages 36 units

Starting at the intermediate level or higher, 4 courses are to be completed in the same language area.

Course List

Complete two courses in a 200-level language sequence* 18 units
82-2xx 200-level language course
82-2xx 200-level language course

* Students who place out of 200-level language courses must take at least two 300-level courses instead of the required one 300-level language course.

Course List

Complete one course in a 300-level language course 9 units
82-3xx 300-level language course

Course List

Complete one 400-level language course (or the next appropriate course in sequence from the 300 level) 9 units
82-4xx 400-level language course

2. Core Courses in History 27 units

Course List

Required Course 9 units
79-207 Development of European Culture

Pre-20th Century European History 9 units

Course List

Complete one 200-level (or above) course in Pre-20th century European History
79-2xx/3xx Pre-20th century European History course

European History 9 units

Course List

Complete one 300-level course in European history
79-3xx European History course

3. European Studies Electives 36 units

This list includes samples of courses that can be taken as appropriate electives in European history, literature, and culture in relevant departments. In any given semester, offerings differ. Students are urged to consult with the Major Advisor and with relevant departments for current offerings. Electives also may include additional 400-level courses in the target language, additional courses in Modern Languages, 200- and 300-level courses in History, and some offerings in English and CFA.

Course List

History
79-208 Europe’s Two Revolutions: Dynamics of Change in the 19th Century

Modern Languages

Course List

French:
82-408 Intermediate French Language and Culture-Advanced Level Special Topics
82-415/416 Topics in French and Francophone Studies

German:
82-427 Nazi and Resistance Culture

Course List

Spanish:
82-441 Studies in Peninsular Literature and Culture
60-377 Picasso and 20th Century Art

Course List

English
76-331 Renaissance Literary and Cultural Studies

New courses will be added as appropriate.

European Studies (B.A.) Sample Curriculum

Plan of Study Grid

Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th></th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>300-level Language Course</td>
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<td>400-level Language Course</td>
</tr>
<tr>
<td>82-3xx</td>
<td>82-4xx</td>
<td></td>
</tr>
<tr>
<td>79-207 Development of European Culture</td>
<td></td>
<td>79-2xx/3xx Pre-20th Century European Course</td>
</tr>
</tbody>
</table>

Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th></th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>European Studies Elective</td>
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<td>European Studies Elective</td>
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<tr>
<td>European Studies Elective</td>
<td></td>
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Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th></th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Studies Elective</td>
<td></td>
<td>European Studies Elective</td>
</tr>
<tr>
<td>European Studies Elective</td>
<td></td>
<td>European Studies Elective</td>
</tr>
</tbody>
</table>
This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed within two years. Students may enter their major, and begin major course requirements, as early as the start at the beginning of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. These students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

### The Major in Information Systems

Faculty Program Director: Randy S. Weinberg  
Office: Porter Hall 224C, rweinberg@andrew.cmu.edu  
Program Advisor: Carol Young  
Office: Porter Hall 220F, caroly@cmu.edu  
Faculty: C.F. Larry Heimann, Jeria Quesenberry, Raja Sooriamrthi  

Information Systems (IS) is a unique and innovative undergraduate interdisciplinary program, drawing on a wide range of exciting college and university strengths. IS is an internationally recognized undergraduate major for students who want to design and implement effective solutions to meet organizational and management needs for information and decision support. IS majors learn how elements of organizations, technology, economics, social aspects and human interaction work together to create effective computer-based information systems to affect real outcomes. Graduates of the Program are ideally situated to take a leading role in managing and shaping our information-based future.

For full program information, go to [https://dietchal肢hesocietysfsciences/informationsystems/](https://dietchal肢hesocietysfsciences/informationsystems/).

### The Major in Linguistics

Tom Werner, Director  
Office: Baker Hall 155F  
Email: twerner@andrew.cmu.edu  

Linguistics is the study of human language, and it encompasses a broad spectrum of research questions, approaches and methodologies. Some linguists are concerned with the cognitive aspects of language learning, production and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic form and meaning, some from a functional and others from a formal perspective. There are also computational approaches to linguistics with both applied and theoretical goals.

The major in Linguistics reflects the multidisciplinary character of the field and of the Linguistics faculty here at Carnegie Mellon, offering a program which provides students with the fundamental tools of linguistic analysis while maintaining a focus on the human context in which language is learned and used. The major is available as either a primary major or an additional major. It is an ideal choice for students with a general interest in their own or other languages, and combines well thematically with studies in any of the departments represented in the major.

### Curriculum

The Linguistics major requires a total of 12 courses, which includes 2 semesters of language study. In addition, primary majors in Linguistics are required to write a Senior Thesis in their final year. At least three courses (not including specific language courses) must be at the 300-level or higher. All courses counted towards the major must be taken for a letter grade and passed with a grade of "C" or above. For Dietrich College students, up to 2 of these courses may be counted also as satisfying the college’s general education requirements (as long as the double-counting maximum established by the college is not exceeded), with permission of the major director.

#### Introductory course

80-180  
Nature of Language

#### Fundamental Skills

Take one course from each of the following core subject areas:

**Sounds**  
80-282  
Phonetics and Phonology

**Structure**  
80-280  
Linguistic Analysis  
76-389  
Rhetorical Grammar  
80-283  
Syntax and Discourse

**Meaning**  
80-381  
Meaning in Language  
80-383  
Language in Use  
76-385  
Introduction to Discourse Analysis

#### Breadth

Take one course from each of the following breadth subject areas:

**Area 1: Language Learning and Language Cognition**

76-420  
Process of Reading and Writing  
82-280  
Learning About Language Learning  
82-383  
Second Language Acquisition: Theories and Research  
82-585  
Topics in Second Language Acquisition  
85-354  
Infant Language Development  
85-421  
Language and Thought

**Area 2: Discourse, Society and Culture**

76-318  
Communicating in the Global Marketplace  
76-385  
Introduction to Discourse Analysis  
76-386  
Language & Culture  
82-273  
Introduction to Japanese Language and Culture  
82-305  
French in its Social Contexts  
82-311  
Arabic Language and Culture I  
82-312  
Arabic Language and Culture II  
82-333  
Introduction to Chinese Language and Culture

#### Electives

Take four additional electives. These can be additional courses from the Fundamental Skills courses or Breadth courses listed above, or any other course which is approved by the Director as a linguistics elective. Listed below are the additional electives taught on a regular basis.

Additional appropriate courses are offered irregularly or on a one-off basis. The Director will provide students with a list of possible electives each semester, and will assist students in selecting electives which are consistent with their goals and interests.

**Electives**

76-373  
Topics in Rhetoric: Argument  
76-378  
Literary: Educational Theory and Community Practice  
76-451  
Topics in Language Study  
76-476  
Rhetoric of Science  
80-281  
Language and Thought  
80-380  
Philosophy of Linguistics  
82-345  
Introduction to Hispanic Literacy and Cultural Studies  
82-373  
Structure of the Japanese Language  
82-378  
Japanese Conversation Analysis  
82-388  
Understanding Second Language Fluency  
82-442  
Analysis of Spoken Spanish  
82-444  
The Structure of Spanish  
82-476  
Japanese Discourse Analysis  
82-480  
Social and Cognitive Aspects of Bilingualism  
82-488  
Language Learning in a Study Abroad Context  
80-382  
Linguistics of Germanic Languages  
11-411  
Natural Language Processing  
11-716  
Graduate Seminar on Dialogue Processing  
11-721  
Grammars and Lexicons  
11-722  
Grammar Formalisms  
11-761  
Language and Statistics  
11-762  
Language and Statistics II

**Language Requirement**

Students must successfully complete two semesters of consecutive language courses. (Note that students may not ‘test out’ of this requirement. However, language courses taken at other institutions or as part of a study abroad program will typically substitute for a semester of language study.)

**Senior Thesis [primary majors only]**

Primary majors must complete a senior thesis (a workload equivalent to a 12-unit course) during their senior year. Topics must be approved by an advisor, who will work with the student and guide the thesis project.

**Notes**

Course numbers 82-305, 82-311, 32-312, 82-373, 82-378, 82-442, 82-444, 82-476 are taught in the language of analysis.

Course number 82-345 topics vary: consult with Director.
All 11-xxx and 15-xxx courses have significant Computer Science prerequisites. Interested students should check with the course instructor before registering.

Language specific “Language and Culture” courses may be taken either as electives or towards the second breadth area. However only one such course per language area may be counted towards the major.

The Major in Psychology and Biological Sciences
This unified major is intended to reflect the interdisciplinary nature of our current research in the fields of psychology and biology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences. Students entering from the Dietrich College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students entering from the Mellon College of Sciences receive a Bachelor of Science in Biological Sciences and Psychology. Students entering from the Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Pre-Major Requirements
The unified major specifies particular pre-major requirements in the areas of mathematical sciences and statistics, natural science, and computational reasoning. Particular courses are specified in these areas because they are prerequisites for courses required in the major and therefore they are the most efficient way to complete the general education requirements for either Dietrich College or SHS. All other general education categories can be filled in any way that satisfies the requirements of the student’s college or of the SHS program.

The major in Psychology and Biological Sciences is offered only as a B.S. degree. Full curriculum requirements can be viewed here (p. 231). http://coursecatalog.web.cmu.edu/collegeofhumanitiesandsocialsciences/departmentofpsychology/ #unifieddoublemajorinpsychologyandbiologicalsciences

Student-Defined Major Program
Joseph E. Devine, Director; Associate Dean for Undergraduate Studies
Office: Baker Hall 154F
Email: jd0x@andrew.cmu.edu
http://www.cmu.edu/hss/sdp

For Dietrich College students whose educational goals cannot be as adequately served by the curricula of existing majors, the college offers the opportunity to self-define a major. The procedure for establishing such a major centers on a written proposal, submitted to the Dietrich College Dean’s Office. This proposal consists of two parts:

Major description and rationale. A description of the components of the proposed program of study; a presentation of the objectives of the program of study, how it represents a coherent and (given available faculty, courses, and other resources) viable course of study, and the reason(s) why these objectives cannot be accomplished within one or more of the college’s existing majors.

The curriculum. Presentation of a complete outline of all courses that will comprise the requirements for the major. These courses should be categorized in two ways: first, according to that component of the major program to which each belongs (e.g., mathematical prerequisites; research methods; theoretical perspectives; etc.); and second, a semester-by-semester outline that indicates when each course is to be taken (or, for any already taken, when taken and grade received). In addition to courses taken at Carnegie Mellon, the major’s curriculum may include courses taken (or to be taken) at other schools, related projects or internships, or programs of study abroad. The minimum requirements for graduation is, as with all majors in the college, 360 units of credit and completion of the Dietrich College general education program.

Proposals and curricula are evaluated for clarity of focus, coherence and depth in related areas, and viability. Proposals should generally be developed no later than the sophomore year, and approved majors begin their program generally no later than the junior year.

The student-defined option is also possible to propose as an additional major or minor. These options extend to undergraduates from all Carnegie Mellon colleges.
### The Minor in African and African American Studies

**Faculty Advisor:** Edda L. Fields-Black  
**Undergraduate Advisor:** Naum Kats  
**Office:** Baker Hall 240

#### Mission

The African and African American Studies minor will expose students to the following regions: sub-Saharan Africa, the Americas, and the Caribbean. Broad geographic coverage and a comparative framework encourage students to make connections between Africa and the Diaspora, as well as among Diasporan communities. The minor offers undergraduate students the opportunity to undertake an empirical and theoretical examination of the cultural, political, social, and historical experiences of Africans and people of African descent. This unique minor brings together departments and colleges within the university and allows students to develop analytical skills particular to the arts, humanities, social sciences, public policy, and management. The African and African American Studies minor is also designed to allow students a considerable degree of freedom in their choice of electives and independent research projects, including opportunities to study and conduct research in a relevant foreign language.

Courses taken to fulfill requirements in other major or minor programs may not be applied to this minor.

**Requirements**

- The minor is composed of 54 units - two core courses and four elective courses.
- The elective courses must include one research course.
- Students may take an additional two core courses as electives, but not more than four total courses.
- Students must take courses in at least two of the four regions (African, African American, Latin American, and the Caribbean) between their core and elective courses.

#### Core Courses 18 units

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-226</td>
<td>Introduction to African History: Earliest Times to 1780</td>
<td>9</td>
</tr>
<tr>
<td>79-227</td>
<td>Introduction to African History: 1780-1994</td>
<td>9</td>
</tr>
<tr>
<td>79-232</td>
<td>African American Literature</td>
<td>9</td>
</tr>
<tr>
<td>79-241</td>
<td>African American History: Africa to the Civil War</td>
<td>9</td>
</tr>
<tr>
<td>79-242</td>
<td>Topics in African American History: Reconstruction to the Present</td>
<td>9</td>
</tr>
<tr>
<td>79-220</td>
<td>Caribbean: Cultures and Histories</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Elective Courses 36 units

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-162</td>
<td>Freshman Seminar: “Slavery” and “Freedom” in African History</td>
<td>9</td>
</tr>
<tr>
<td>79-225</td>
<td>West African History in Film</td>
<td>9</td>
</tr>
<tr>
<td>79-237</td>
<td>Comparative Slavery</td>
<td>9</td>
</tr>
<tr>
<td>79-290</td>
<td>States/Stateless Societies and Nationalism in West Africa</td>
<td>6</td>
</tr>
<tr>
<td>79-391</td>
<td>Globalization in East African History</td>
<td>6</td>
</tr>
<tr>
<td>79-385</td>
<td>The Making of the African Diaspora</td>
<td>9</td>
</tr>
<tr>
<td>79-386</td>
<td>Entrepreneurs in Africa, Past, Present and Future</td>
<td>9</td>
</tr>
<tr>
<td>82-304</td>
<td>The Francophone World</td>
<td>9</td>
</tr>
<tr>
<td>88-370</td>
<td>African Politics</td>
<td>9</td>
</tr>
<tr>
<td>57-480/19-357</td>
<td>History of Black American Music</td>
<td>6</td>
</tr>
<tr>
<td>76-333</td>
<td>African American Literature</td>
<td>9</td>
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<tr>
<td>76-432</td>
<td>Advanced Seminar in African American Studies</td>
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</tr>
<tr>
<td>79-237</td>
<td>Comparative Slavery</td>
<td>9</td>
</tr>
<tr>
<td>79-243</td>
<td>African American Women’s History</td>
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<tr>
<td>79-286</td>
<td>Gandhi and King: Nonviolent Leadership in a Globalized World</td>
<td>9</td>
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<tr>
<td>79-304</td>
<td>African Americans in Pittsburgh</td>
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<tr>
<td>79-371</td>
<td>African American Urban History</td>
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<td>79-235</td>
<td>Caribbean Cultures</td>
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<td>79-237</td>
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<td>79-295</td>
<td>Race Relations in the Atlantic World</td>
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<td>79-385</td>
<td>The Making of the African Diaspora</td>
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<tr>
<td>82-304</td>
<td>The Francophone World</td>
<td>9</td>
</tr>
<tr>
<td>82-454</td>
<td>The Hispanic Caribbean: Rhyme, Reason and Song</td>
<td>9</td>
</tr>
</tbody>
</table>

**Notes:**

- * Denotes courses that require a research paper/project and fulfill requirement for research course
- ** Denotes courses taught in a foreign language
other advanced course option, the faculty minor advisor will work with the student to identify an alternative course for this requirement.

NOTE: The courses listed below are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

Science Prerequisites* 19 units

<table>
<thead>
<tr>
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<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-105</td>
<td>Intro to Modern Chemistry I (equivalent to at least 18 Carnegie Mellon units) at the University of Pittsburgh (see faculty minor advisor)</td>
<td>10</td>
</tr>
</tbody>
</table>

OR

Pre-approved environmentally-related science courses (equivalent to at least 18 Carnegie Mellon units) which may also be taken at the University of Pittsburgh (see faculty minor advisor).

* These science courses may double count with other major and minor requirements.

Required Courses 18 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>73-148</td>
<td>Environmental Economics</td>
<td>9</td>
</tr>
<tr>
<td>80-244</td>
<td>Environmental Ethics</td>
<td>9</td>
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</table>

Intermediate (Distributional) Requirements 27 units

<table>
<thead>
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<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>73-358</td>
<td>Economics of the Environment and Natural Resources</td>
<td>9</td>
</tr>
<tr>
<td>88-220</td>
<td>Policy Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>90-765</td>
<td>Cities, Technology and the Environment</td>
<td>6</td>
</tr>
<tr>
<td>90-798</td>
<td>Environmental Policy &amp; Planning</td>
<td>12</td>
</tr>
<tr>
<td>80-808</td>
<td>Energy Policy</td>
<td>6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-319</td>
<td>Environmental Rhetoric</td>
<td>9</td>
</tr>
<tr>
<td>76-476</td>
<td>Rhetoric of Science</td>
<td>9</td>
</tr>
<tr>
<td>79-372</td>
<td>Perspectives on the Urban Environment</td>
<td>9</td>
</tr>
<tr>
<td>79-374</td>
<td>American Environmental History: Critical Issues</td>
<td>9</td>
</tr>
<tr>
<td>79-375</td>
<td>China's Environmental Crisis</td>
<td>9</td>
</tr>
<tr>
<td>79-377</td>
<td>Food, Culture, and Power: A History of Eating</td>
<td>9</td>
</tr>
<tr>
<td>79-381</td>
<td>Energy, Environment, Globalization in the Americas</td>
<td>9</td>
</tr>
<tr>
<td>80-244</td>
<td>Environmental Ethics</td>
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Advanced Course 9 units

<table>
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</tr>
<tr>
<td>19-452</td>
<td>EPP Projects</td>
<td>12</td>
</tr>
</tbody>
</table>

[pre-approved sections] or [additional courses may be approved in consultation with the advisor.]

The Minor in European Studies

Faculty Advisors: Ken C. Dworkin (Hispanic Studies), Chris Hallstein (German), or Bonnie Youngs (French & Francophone Studies)

Offered jointly by Modern Languages and History, the Minor in European Studies is a unique interdisciplinary program that seeks to develop and enhance students’ understanding of European societies and cultures. It aims to train students in literature and language, cultural history and the arts, as well as related areas of professional opportunity. It offers substantive knowledge of Western European society through two approaches. First, it provides a foundation in one of the continental Western European languages. Second, it encourages comparative inquiry across boundaries of time, nation, and scholarly discipline.

Curriculum 54 units

Offered jointly by the Departments of Modern Languages and History.
The Minor in Gender Studies

Faculty Advisor: Kristina Straub
Office to declare minor: English, Baker Hall 259

Gender studies is an interdisciplinary field that investigates how gender is embedded in social, cultural, and political relationships. It understands gender as a category of power that intersects with other power relations, including race, class, and sexuality. Courses allow students to develop a deeper understanding of how gender operates, and to transfer the analytical skills they acquire to other courses as well as to their personal and professional lives. The minor combines coursework in English, history, anthropology, psychology, philosophy, economics, and modern languages.

Courses taken to fulfill requirements in other major or minor programs may not be applied to the Gender Studies minor requirements (and vice versa).

Curriculum 54 units

The courses listed below are offered with at least general regularity. Participating departments may develop and offer other courses that, while not listed here, are appropriate for the study of gender. Consult the minor advisor to confirm the relevance of unlisted, gender-focused courses.

Required Introductory Courses 18 units

Complete one of the following (9 units):
76-241 Introduction to Gender Studies
9
79-331 Body Politics: Women and Health in America
9

and one of the following (9 units):
79-244 Women in American History
9
79-320 Women, Politics, and Protest
9

Elective Intermediate Courses 27 units

Choose three of the following courses:
76-241 Introduction to Gender Studies *
9
76-245 Shakespeare: Histories and Tragedies
9
76-341 Advanced Gender Studies
9
79-243 African American Women's History
9
79-244 Women in American History *
9
79-320 Women, Politics, and Protest *
9
79-322 Family and Gender in Russian History
9
79-331 Body Politics: Women and Health in America
9
85-221 Principles of Child Development
9
85-352 Evolutionary Psychology
9

* If not taken as required introductory course

Elective Advanced Courses 9 units

Choose one of the following courses (9 units):
76-412 18th Century Literary and Cultural Studies
9
76-422 Theories of Sexuality and Gender
9
79-379 Extreme Ethnography
9
82-407 The Arts in Society
1

As an alternative, in extenuating circumstances, students may substitute another 9-unit course from the “Intermediate Course” list above with the approval of the minor faculty advisor. Students may also take more than 9 units from the “Advanced Course” list to count for the 54 unit total. For information about additional course offerings, contact Kristina Straub, ks3t@andrew.cmu.edu, 412-268-6458.

The Minor in Global Systems and Management

Faculty Advisor: Carol S. Young
Office: PH 222F

The Global Systems and Management minor (GSM) is intended for students wishing to develop skills essential for participating in emerging opportunities in global business systems, systems development, product development and global project management. GSM exposes students to contemporary issues and practices facing organizations, managers and individuals working on a global scale across political, cultural and temporal boundaries. GSM presents an opportunity for students to learn about being part of an organization that works globally with its employees, business partners, customers and supply chains.

Students will learn about global project management, outsourcing and cross-cultural communications from theoretical and practical viewpoints. An organized elective structure enables students to tailor the minor reflect their specific interests.

Curriculum 54 units

GSM is offered jointly across the departments and programs of the Dietrich College of Humanities and Social Sciences with participation from the Tepper School of Business. The minor is administered by the Dietrich College Information Systems program. The minor requires students to complete:

• one Information Systems course: 67-329 Contemporary Themes in Global Systems offered only in the Spring semester
• two courses in Communications
• one or two courses in Humanities, Heritage and Culture
• one or two courses in International Management

Study Abroad Options

Students are encouraged to complete a semester of study abroad. With prior approval from the GSM Advisor, study abroad courses may be applied to GSM minor requirements except for 67-329 Contemporary Themes in Global Systems. The GSM Advisor should be consulted before embarking on the semester of study abroad.

NOTE: Participating departments may develop and offer other courses that, while not listed here, are deemed appropriate for GSM. Students may develop and submit to the GSM Advisor customized plans that substantially meet the requirements of this minor while allowing the student a personally-crafted learning experience. Proposals should generally be developed no later than the sophomore year, and the minor program started no later than junior year. Proposals will be evaluated for clarity of focus, coherence and depth in areas related to global project development and viability within the context of the Dietrich College and University. Prior approval must be obtained to begin a customized course of study.

Double Counting of Courses

Students may apply one course taken to fulfill a requirement in another major or minor program toward the GSM minor.

Core Course

67-329 Contemporary Themes in Global Systems
(Spring Semester Only)

Communications 18 units

Complete two courses:
70-340 Business Communications
9
70-342 Managing Across Cultures
9
76-270 Writing for the Professions
9
76-318 Communicating in the Global Marketplace
9
76-386 Language & Culture
9
85-375 Crosscultural Psychology
9

Humanities, Heritage and Culture 9-18 units

Complete courses totaling 9-18 units (generally 1 or 2 courses):

• History Department courses: 200-level or above covering international/regional studies that are outside of U.S. history

OR

• Modern Languages Department courses: 200-level or above, covering international or regional studies but not including elementary or intermediate language courses
International Management 9-18 units
Complete courses totaling 9-18 units (generally 1 or 2 courses).
70-331 Technology Consulting in the Global Community 3
70-342 Managing Across Cultures 9
70-365 International Trade and International Law 9
70-430 International Management 9
70-480 International Marketing 9
73-371 International Trade and Economic Development 9
73-372 International Money and Finance 9
88-326 Theories of International Relations 9
88-384 Conflict and Conflict Resolution in International Relations 9
88-411 The Rise of the Asian Economies 9
88-412 Economics of Global Warming 9
88-413 Global Competitiveness: Firms, Nations, and Technological Change 9
88-357 Comparative Foreign Policy: China, Russia, and the US 9
88-359 Globalization 9
88-378 International Economics 9

GLOBAL SYSTEMS AND MANAGEMENT MINOR REQUIRES A TOTAL OF: 54 UNITS

Minor in Health Care Policy and Management
Sponsored by: H. John Heinz III College
Dietrich College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:
Caroline Ackerman, Dietrich College of Humanities and Social Sciences
Patti Lee, H. John Heinz III College
Justin Crowley, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum 60 units minimum

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100 Principles of Economics or 88-220 Policy Analysis I or the equivalent by approval.

Required Courses 39 units
Students are required to take the following courses.
79-330 Medicine and Society 9
90-836 Health Systems 6
90-861 Health Policy 6
94-705 Health Economics 12

27 units
Elective Courses
Complete a minimum of 27 units.

Heinz College Courses
90-708 Healthcare Ethics 6
90-721 Healthcare Management 6
90-818 Health Care Quality & Performance Improvement 6
90-830 Introduction to Financial Management of Health Care 6
90-831 Advanced Financial Management of Health Care 6
90-832 Health Law 12
90-863 Health Policy II 6
94-706 Healthcare Information Systems 12

Humanities and Social Sciences Courses (9 units each)
76-494 Healthcare Communications 9
79-335 Drug Use and Drug Policy 9
79-383 Epidemic Disease and Public Health 9
80-245 Medical Ethics 9
80-247 Ethics and Global Economics 9

85-242 Social Psychology 9
85-442 Health Psychology 9
85-446 Psychology of Gender 9

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

The Minor in Linguistics
Tom Werner, Director
Office: Baker Hall 155F
Email: twerner@andrew.cmu.edu

Linguistics is the study of human language, and it encompasses a broad spectrum of research questions, approaches and methodologies. Some linguists are concerned with the cognitive aspects of language learning, production and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic form and meaning, some from a functional and others from a formal perspective. There are also computational approaches to linguistics with both applied and theoretical goals.

The interdepartmental Minor in Linguistics is sponsored by the departments of English, Modern Languages, Philosophy and Psychology and the Language Technologies Institute. It synthesizes the linguistics related offerings in these departments and provides students with an academic experience that reflects both the interdisciplinary character of the subject and its cross-departmental representation at Carnegie Mellon.

Curriculum
The Linguistics Minor requires a total of 6 courses. All courses counted towards the Minor must be taken for a letter grade and passed with a grade of "C" or above. For Dietrich College students, up to 2 of these courses may be counted also as satisfying the college's general education requirements (as long as the double-counting maximum established by the college is not exceeded), with permission of the director.

Introductory course
80-180 Nature of Language 9

Fundamental Skills
Take one course from two of the following core subject areas:

Sounds
80-282 Phonetics and Phonology 9

Structure
80-280 Linguistic Analysis 9
76-389 Rhetorical Grammar 9
80-283 Syntax and Discourse 9

Meaning
80-381 Meaning in Language 9
80-383 Language in Use 9
76-385 Introduction to Discourse Analysis 9

Electives
Take three additional courses. These can be additional courses from the Fundamental Skills category above, or any other course which is approved by the director as a linguistics elective. Listed below are the additional electives taught on a regular basis. Other appropriate courses are offered irregularly or on a one-off basis. The director will provide students with a list of possible electives each semester.

Electives are listed below with an indication of the broad areas into which they fall. Students are free to select any configuration of courses from any areas. The director will assist students in selecting electives which are consistent with their goals and interests.

Language Learning and Cognition
76-378 Literacy: Educational Theory and Community Practice 9
76-420 Process of Reading and Writing 9
80-281 Language and Thought 9
82-480 Social and Cognitive Aspects of Bilingualism 9
82-280 Learning About Language Learning 9
82-383 Second Language Acquisition: Theories and Research 9
82-388 Understanding Second Language Fluency 9
82-488 Language Learning in a Study Abroad Context 9
85-354 Infant Language Development 9
85-421 Language and Thought 9

Discourse, Society and Culture
76-318 Communicating in the Global Marketplace 9
76-325 Topics in Rhetoric 9
76-373 Topics in Rhetoric: Argument 9
76-385 Introduction to Discourse Analysis 9
76-386 Language & Culture 9
76-457 Topics in Rhetoric 9
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Neuroscience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-363</td>
<td>Systems Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-761</td>
<td>Neural Plasticity</td>
<td>9</td>
</tr>
<tr>
<td>85-765</td>
<td>Cognitive Neuroscience</td>
<td>Var.</td>
</tr>
<tr>
<td>Pitt-Neuroscience 1000 Introduction to Neuroscience</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Pitt-Neuroscience 2012 Neurophysiology</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>C. Cognitive Psychology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
<tr>
<td>85-428</td>
<td>Neo Basis of Cognitive Development</td>
<td>9</td>
</tr>
<tr>
<td>85-765</td>
<td>Cognitive Neuroscience</td>
<td>Var.</td>
</tr>
<tr>
<td>D. Intelligent System Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-601</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>15-381</td>
<td>Artificial Intelligence: Representation and Problem Solving</td>
<td>9</td>
</tr>
<tr>
<td>15-385</td>
<td>Computer Vision</td>
<td>9</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>15-486</td>
<td>Artificial Neural Networks</td>
<td>12</td>
</tr>
<tr>
<td>15-494</td>
<td>Special Topic: Cognitive Robotics</td>
<td>12</td>
</tr>
<tr>
<td>16-299</td>
<td>Introduction to Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>16-311</td>
<td>Introduction to Robotics</td>
<td>12</td>
</tr>
<tr>
<td>24-352</td>
<td>Dynamic Systems and Controls</td>
<td>12</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
<td>9</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
<td>9</td>
</tr>
<tr>
<td>36-410</td>
<td>Introduction to Probability Modeling</td>
<td>9</td>
</tr>
</tbody>
</table>

**Notes**

Course numbers 82-305, 82-311, 82-312, 82-378, 82-476, 82-373, 82-442, 82-444 are taught in the language of analysis.

All 11-xxx and 15-xxx courses have significant Computer Science prerequisites. Interested students should check with the course instructor before registering.

**Neural Computation Minor**

**Director:** Dr. Tai Sing Lee  
**Administrative Coordinator:** Melissa Stupka  
**Website:** [http://www.cnbc.cmu.edu/upnc/nc_minor/](http://www.cnbc.cmu.edu/upnc/nc_minor/)

The minor in Neural Computation is an intercollege minor jointly sponsored by the School of Computer Science, the Mellon College of Science, and the Dietrich College of Humanities and Social Sciences, and is coordinated by the Center for the Neural Basis of Cognition (CNBC) ([http://www.cnbc.cmu.edu](http://www.cnbc.cmu.edu)).

The Neural Computation minor is open to students in any major of any college at Carnegie Mellon. It seeks to attract undergraduate students from computer science, psychology, engineering, biology, statistics, physics, and mathematics from SCS, CIT, Dietrich College and MCS. The primary objective of the minor is to encourage students in biology and psychology to take courses in neuroscience and mathematics courses on the one hand, and to encourage students in computer science, engineering, statistics and physics to take courses in neuroscience and psychology on the other, and to bring students from different disciplines together to form a community. The curriculum and course requirements are designed to maximize the participation of students from diverse academic disciplines.

The program seeks to produce students with both basic computational skills and knowledge in cognitive science and neuroscience that are central to computational neuroscience.

**Curriculum**

The minor in Neural Computation will require a total of five courses: four courses drawn from the four core areas (A: neural computation, B: neuroscience, C: cognitive psychology, D: intelligent system analysis), one from each area, and one additional depth elective chosen from one of the core areas that is outside the student’s major. The depth elective can be replaced by a one-year research project in computational neuroscience. No more than two courses can be double counted toward the student’s major or other minors. However, courses taken for general education requirements of the student’s degree are not considered to be double counted.

A course taken to satisfy one core area cannot be used to satisfy the course requirement for another core area. The following listing presents a set of current possible courses in each area. Other computational neuroscience courses are being developed at Carnegie Mellon and University of Pittsburgh that will also satisfy core area A requirement and the requirements will be updated as they come on-line. Substitution is possible but requires approval.

**A. Neural Computation**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>15-483</td>
<td>Computational Models of Neural Systems</td>
<td>12</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
<tr>
<td>Pitt-Mathematics 1800 Introduction to Mathematical Neuroscience</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
The Religious Studies minor provides the student with a range of intellectual tools with which to think about religious ideas, behaviors and institutions. A further objective is to enable the student to build a base of knowledge which extends beyond any one particular religious tradition. The minor consists of six courses, totaling at least 54 units.

Courses taken to fulfill requirements in other major or minor programs may not be applied to this minor.

Curriculum 54 units

In addition to the general education requirements of the student's college and the requirements of the student's major, Religious Studies minors must satisfy the requirements as outlined below.

The "required" course listed below is offered regularly; the "distribution" and "elective" courses are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

Core Course 9 units

This required course introduces a variety of methods of religious inquiry such as philosophy of religion, sociological and behavioral approaches to religion, historical analysis of religious subject matter, literary and critical analysis of religious texts, theological modes of thought, and anthropological treatments of religion.

79-281 Introduction to Religion 9

Distribution Requirements 18 units

A distribution course is one that applies a particular discipline to more than one religion. Complete a course from each of two different disciplinary approaches. See the faculty advisor for other options.

Anthropological Approaches

79-330 Religion of China 9

Historical Approaches

79-272 Iberian Encounters: Muslims, Christians and Jews in Spain 9

79-307 Religion and Politics in the Middle East 9

79-353 Religious Identities and Religious Conflicts in 19th Century Europe 9

Philosophical Approaches

80-276 Philosophy of Religion 9

Textual Approaches

76-346 Renaisance Studies 9

79-325 Art and Religion 9

Elective Courses 27 units

Complete courses totaling at least 27 units. In addition to the Carnegie Mellon courses listed below, electives may be chosen from among any of the courses listed above under "Distribution Requirements" that were not used to fulfill that requirement.

76-330 Medieval Literature 9

76-430 Medieval Literature 9

79-202 Faith and Spirit: Early Modern Europe, 1400-1750 9

79-254 The Jewish Diaspora in Latin America 9

79-349 The Holocaust in Historical Perspective 9

79-350 Early Christianity 9

79-352 Christendom Divided: The Protestant and Catholic Reformation 1450-1600 9

82-313 Readings in Islamic History 9

Students may cross-register for relevant electives at other Pittsburgh institutions with the permission of the faculty advisor for the religious studies minor.

The Minor in Science, Technology and Society

Faculty Advisor: Jay Aronson
Undergraduate Advisor: Naum Kats
Office: Baker Hall 240

This minor provides varied perspectives on the development and meaning of science and technology in modern society. The core courses provide for the exploration of the philosophical underpinnings, cultural and historical contexts, and economic and literary assessments of the interplay among science, technology, and society. Elective courses allow students to pursue more deeply subjects and approaches that build on both core courses and students' primary majors.

Courses taken to fulfill requirements in other major or minor programs may not be applied to this minor.

Curriculum 54 units

Complete one course from Area 1, two from Area 2, and 3 Electives.

Area 1: Language and Rhetoric in Science and Technology 9 units

71-326 Photography & Family 9

76-319 Environmental Rhetoric 9

76-395 Science Writing 9

76-425 Science in the Public Sphere 9

76-466 Rhetoric of Science 9

76-492 Rhetoric of Public Policy 9

Area 2: History, Philosophy and Social Studies of Science and Technology (18 units)

79-330 Medicine and Society 9

79-333 Biology and Society: Evolution Animal Experimentation and Eugenics 9

79-334 Law, Ethics, and the Life Sciences 9

79-342 Introduction to Science and Technology Studies 9

79-382 History of Biomedical Research 9

80-226 Revolutions in Science 9

80-323 Philosophy of Biology 9

Electives 27 units

Complete three courses from the approved list of elective courses. Courses listed in Areas 1, 2 and 3 may also be taken as electives if not already completed for an Area requirement. For a listing of approved courses, consult the description of the minor in Science, Technology and Society on the Dietrich College of Humanities and Social Sciences' webpage (http://www.hss.cmu.edu/index.html), or contact the faculty advisor directly at aronson@andrew.cmu.edu.

15-xxx Special Topics 9-12

17-400 Electronic Voting 12

18-482 Telecommunications, Technology Policy & Management 12

19-448 Science, Technology & Ethics 9

39-100 Special Topics: WHAT IS ENGINEERING? 9

48-448 History of Sustainable Architecture 9

79-331 Body Politics: Women and Health in America 9

79-332 Medical Anthropology 9

79-335 Drug Use and Drug Policy 9

79-381 Energy, Environment, Globalization in the Americas 9

79-383 Epidemic Disease and Public Health 9

80-245 Medical Ethics 9

80-247 Ethics and Global Economics 9

80-341 Computers, Society and Ethics 9

88-343 Economics of Technological Change 9

85-380 In Search of Mind: The History of Psychology 9

The Minor in Sociology

Faculty Advisor, David Hounshell
Program Advisor, Connie Angermeyer
Office: Porter Hall 208A

The Sociology minor provides the student with a solid introduction to the central concepts in sociological theory and a grounding in the methods of empirical inquiry needed to understand societies, their histories, and how they change over time. Students choose among selected topics including social psychology, work and organizations, social networks, technology and society, medical sociology, and gender and family. Exposure to these topics will help students understand and appreciate the processes by which families, groups, and organizations form and evolve over time; by which individuals affect and are affected by the society in which they live; and by which technology and institutions shape and influence society. This background in empirical tools and social theory will strengthen students' ability to enter graduate studies in sociology, social history, social science, and organizational theory; to begin professional careers involving social analysis, network analysis, data analysis of teams, groups and organizations, social analysis within journalism, political institutions, the government; and to enter the corporate environment with a thorough understanding of organizational activity.

Curriculum 54 units

In addition to the general education requirements of the student's college and the requirements of the student's major, Sociology minors must satisfy the following requirements. The Core courses comprise 18 units of the minor. One course is taken from the Organizations cluster, and one course is taken from the Methodology cluster. The Elective courses comprise 36 units of the minor. Sociology minors should consult with the program advisor to plan a course schedule prior to registration.
NOTE: The core courses are offered regularly; the elective courses are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The program advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

No more than 9 units in the Sociology minor may be counted to fulfill any other major or minor’s requirements.

Core Courses 18 units

- **a. Organizations**
  - Complete one course.
  - 70-311 Organizational Behavior 9
  - 88-260 Organizations 9

- **b. Methodology**
  - Complete one course.
  - 36-202 Statistical Methods 9
  - 70-208 Regression Analysis 9
  - 88-351 Empirical Research Methods 9

Elective Courses 36 units

Complete four courses (a minimum of 36 units) from the following list. Two courses (18 units) must be taken from one category to complete the depth requirement. One course (9 units) must be taken from the other category. The remaining course (9 units) may be taken from either category. Appropriate courses offered by the Department of Sociology at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this option. Contact the Sociology program advisor for more information.

1. Sociology of Gender, Family, and Culture
   - 70-342 Managing Across Cultures 9
   - 79-244 Women in American History 9
   - 79-261 Chinese Culture and Society 9
   - 79-308 18th Century China Through Literature 9
   - 79-320 Women, Politics, and Protest 9
   - 79-322 Family and Gender in Russian History 9
   - 79-323 Family Gender and Sexuality in European History, 500-1800 9
   - 79-329 History of Feminist Theory 9
   - 79-331 Body Politics: Women and Health in America 9
   - 79-332 Medical Anthropology 9
   - 79-333 Education and Social Reform 9
   - 79-334 Juvenile Delinquency Through Film 6
   - 79-340 Gender, Race, and American Sport: Historical and Contemporary Perspectives 9
   - 79-343 History of American Urban Life 9
   - 79-368 Poverty, Charity, and Welfare 9
   - 79-379 Extreme Ethnography 9
   - 80-230 Ethical Theory 9
   - 80-245 Medical Ethics 9
   - 80-305 Rational Choice 9
   - 85-241 Social Psychology 9
   - 85-446 Psychology of Gender 9

2. Sociology of Work, Organizations, and Technology
   - 70-332 Business, Society and Ethics 9
   - 70-414 Technology Based Entrepreneurship for CIT 9
   - 73-432 Economics of Education 9
   - 79-342 Introduction to Science and Technology Studies 9
   - 80-291 Issues in Multimedia Authoring 9
   - 80-341 Computers, Society and Ethics 9
   - 88-341 Organizational Communication 9
   - 88-345 Perspectives on Industrial Research and Development 9
   - 88-347 Complex Technological Systems: Past, Present, and Future 9
   - 88-371 Entrepreneurship, Regulation and Technological Change 9
   - 88-391 Technology and Economic Growth 9
   - 88-402 Modeling Complex Social Systems 9
   - 88-415 Global Competitiveness: Firms Nations, and Technological Change 9
   - 88-419 Negotiation 9
   - 88-423 Institutions, Entrepreneurship, and Innovation 9
   - 88-435 Analytical Methods for Complex Social Systems 9
   - 88-451 Policy Analysis Senior Project 12
   - or 88-452 Policy Analysis Senior Project

Note: Some courses have additional prerequisites.
The Undergraduate Economics Program

Dennis Eggipse, Head of Economics
Carol B. Goldberg, Director of Undergraduate Economics
Program Office: Tepper School of Business, Room 139
E-mail: econprog@andrew.cmu.edu
Advising Appointment Online Scheduler: www.tepper.cmu.edu/econadvising
http://www.tepper.cmu.edu/undergraduate-economics

At its most fundamental level, economics is the study of how scarce resources are allocated. What will be produced and consumed, how much, and by whom? These questions, central to the well-being of people throughout the world, are the focus of economics. Economists identify, model, and analyze problems, developing meaningful solutions for the challenges confronting society. Economists are active participants in the processes and institutions through which the pressing concerns of society are addressed. Economists help businesses, political bodies, and other organizations make better decisions through the application of economic analysis, development of market strategies, promotion of regulatory structures, and formulation of appropriate government policies. Increasingly, economists are taking advantage of new technologies to design and implement new markets and exchange mechanisms.

Carnegie Mellon University enjoys a rich history of innovative research in the field of economics. By bringing together rigorous theoretical and empirical work, the University supports some of the very best research. Eight of our past and present faculty have been awarded the Nobel Prize in Economics. In the classroom, we bring the same rigorous, innovative approach to enable our students to develop their talents and realize the potential of their tremendous analytical skills. Our students also benefit from a strong culture of interdisciplinary collaboration and exposure to a broad range of research.

The Undergraduate Economics Program has a unique position at Carnegie Mellon University. It is the sole undergraduate program that is a joint program of the Tepper School of Business and the Dietrich College of Humanities and Social Sciences. The combination of research strength (Tepper has been home to eight Nobel Laureates in Economics) and commitment to liberal arts and interdisciplinary studies (Dietrich has “the most creative general education program of any American university” – New York Times) provides our undergraduates with a world-class economics program.

Economics majors are considered members of both colleges and enjoy their full support and services of both. Undergraduate economics students should consult the program’s website and handbook for details about applicable Pepper and Dietrich academic policies and procedures.

Educational Objectives

The Undergraduate Economics Program offers a range of degrees in economics designed to develop strong analytical skills and a solid foundation in the discipline of economics. More specifically, measurable objectives for our economics curriculum are the following:

- Students should be able to identify, explain, and use economic concepts, theories, models, and data-analytic techniques.
- Students should acquire and use knowledge of economics, mathematics, statistics, and computing flexibly in a variety of contexts, providing the foundation for success in graduate studies and careers in the public and private sectors.
- Students should be able to apply their economic tools to formulate positions on a wide range of social and economic problems and engage effectively in policy debates.
- Students should use the investigative skills necessary for conducting original economic research and participating effectively in project teams.
- Students should be able to deliver effective presentations in which they combine visual communication design with oral arguments and/or the written word.

Advising

The Undergraduate Economics Program is committed to providing students with the opportunity to have meaningful and informative discussions about their academic, intellectual, and career interests with a wide range of advisors and mentors. In college, advising meetings are not the same thing as “being sent to the principal’s office in high school.” Instead, these are extended discussions which may address both immediate and long-term interests, concerns, and desires/needs.

The economics curriculum is cumulative, higher-level courses build upon the foundations learned in the core course. This results in students needing to be aware of course-sequencing and the schedule of classes. Students are encouraged to meet frequently with their Undergraduate Economics Program academic advisor to ensure that their courses fulfill the requirements towards their degree and are appropriately sequenced. Historically, successful students typically checked-in with their advisor frequently and sought the advice of their academic advisor in selecting courses, pursuing additional degrees, and planning ahead for study abroad.

All students taking economics courses are invited to meet with an economics advisor. Students pursuing a degree in economics are assigned an economics advisor who meets with them on a regular basis.

To facilitate scheduling advising meetings, please use the online appointment scheduler found on the Undergraduate Economics Program’s Advising Website (http://www.tepper.cmu.edu/econadvising) (www.tepper.cmu.edu/econadvising)

Curricula

In order to accommodate students’ wide variety of goals, four primary degree programs are available: Bachelor of Science in Economics, Bachelor of Science in Mathematical Sciences (jointly administered by the Department of Mathematics and the Undergraduate Economics Program), and Bachelor of Science in Economics and Statistics (jointly administered by the Department of Statistics and the Undergraduate Economics Program).

The four major degree programs have been designed to provide students with a solid understanding of the central theories and analytical tools of the field of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. The four degrees produce strong analytical thinkers who are able to model and analyze complex problems. Graduates of the Undergraduate Economics Program gain employment as economic analysts in both the private and public sectors; pursue advanced professional degrees in business, law, and public policy; as well as enter into Ph.D. programs in economics, statistics, finance, and related fields.

First-year students are not expected to know which degree option they wish to pursue. For this reason, the first-year curricula are quite similar for the four degrees. As students become involved in their course work, participate in the extra- and co-curricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes evident.

For students who majored in other academic fields, additional major programs in Economics and in Economics and Statistics and two minor degree program in Economics and in Innovation, Economics, and Entrepreneurship are available. Information about these degrees can be found following the discussions about the major curricula.

Major Degree Requirements and Sample Schedules

In addition to completing a minimum 360 units and fulfilling both the Dietrich General Education requirements and all University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economic theory, and economic analysis, as well as a set of advanced electives and other specialized courses.

Following the list of requirements for each degree are sample four-year course schedules for a student pursuing undergraduate degrees in economics. As there are many different ways of completing the requirements, students are strongly encouraged to meet with an economics advisor to tailor their courses to their own particular needs. Students are responsible for ensuring that they understand all of the program requirements and that they meet the necessary conditions for graduation. When planning course schedules, students must give consideration to all prerequisite and co-requisite requirements.

B.A. in Economics

The B.A. in Economics curriculum is designed to provide students with a deep understanding of economic theory, quantitative economic analysis, and how economics can be used to solve current social problems. It is a goal of the degree program to have students develop an ability to observe and identify contemporary problems, and then provide solutions. Built into the
degree is the opportunity to study political, historical, cultural, and social institutions from other CMU departments; these courses are referred to as "Special Electives". The advanced data analysis component of the B.A. in Economics Curriculum pays additional attention to ordinal data and the study of surveys. The capstone of the curriculum is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies.

B.A. in Economics Curriculum

Mathematics Prerequisites (19 units)

- 21-120 Differential and Integral Calculus (10 units)
- 21-256 Multivariate Analysis (9 units)

Sophomore Economics Colloquium (1 unit)

- 73-450 Economics Colloquium (1 unit)

Writing Requirement (9 units)

- 73-270 Writing for Economists (9 units)

Economic Theory Requirements (27 units)

- 73-100 Principles of Economics (9 units)
- 73-230 Intermediate Microeconomics (9 units)
- 73-240 Intermediate Macroeconomics (9 units)

Economic History Requirement (9 Units)

- 73-310 Evolution of Economic Ideas and Analysis (9 units)

Quantitative Analysis Requirements (54 Units)

- 36-201 Statistical Reasoning and Practice (9 units)
- 36-202 Statistical Methods (9 units)
- 36-207 Probability and Statistics for Business Applications (9 units)
- 36-208 Probability and Statistics for Business Applications (9 units)
- 36-217 Probability Theory and Random Processes (9 units)
- 36-225 Introduction to Probability Theory (9 units)
- 73-240 Intermediate Macroeconomics (9 units)
- 73-407 Fundamentals of Statistical Modeling (9 units)
- 73-450 Economics Colloquium (1 unit)

Advanced Economics Electives (36 Units)

Students must take four advanced elective courses. Advanced elective courses are numbered 73-300 through 73-495, as well as selected courses designated by the Program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Special Electives (27 Units)

Students must take three special elective courses in the humanities and social sciences. The complete list of courses designated as special electives is maintained, revised, and published online each semester by the Undergraduate Economics Program. The list below is representative of the courses that qualify as "Special Electives;" this is not an exhaustive list of qualifying courses. In particular, the graduate courses from Heinz College which open to B.A. in Economics students are not presented.

Course List

Representative List of "Special Elective" Courses

<table>
<thead>
<tr>
<th>Units</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>79-221 Development and Democracy in Latin America</td>
</tr>
<tr>
<td>9</td>
<td>79-246 Industrial America</td>
</tr>
<tr>
<td>9</td>
<td>79-300 History of American Public Policy</td>
</tr>
<tr>
<td>9</td>
<td>79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967</td>
</tr>
<tr>
<td>9</td>
<td>79-335 Drug Use and Drug Policy</td>
</tr>
<tr>
<td>9</td>
<td>79-375 China's Environmental Crisis</td>
</tr>
<tr>
<td>9</td>
<td>79-386 Entrepreneurs in Africa, Past, Present and Future</td>
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<tr>
<td>9</td>
<td>80-130 Introduction to Ethics</td>
</tr>
<tr>
<td>9</td>
<td>80-136 Social Structure, Public Policy &amp; Ethics</td>
</tr>
<tr>
<td>9</td>
<td>80-221 Philosophy of Social Science</td>
</tr>
<tr>
<td>9</td>
<td>80-235 Political Philosophy</td>
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<tr>
<td>9</td>
<td>88-260 Organizations</td>
</tr>
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<td>9</td>
<td>88-305 Natural Choice</td>
</tr>
<tr>
<td>9</td>
<td>88-321 Causal, Law, and Social Policy</td>
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<tr>
<td>9</td>
<td>88-348 Health Development and Human Rights</td>
</tr>
<tr>
<td>9</td>
<td>88-365 Behavioral Economics and Public Policy</td>
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<tr>
<td>9</td>
<td>88-387 Social Norms and Economics</td>
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<tr>
<td>9</td>
<td>88-412 Economics of Global Warming</td>
</tr>
</tbody>
</table>

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)

- 73-497 Senior Project (9 units)
- or 73-500 Tepper College Honors Thesis I (9 units)
- or 73-501 and Tepper College Honors Thesis II (9 units)
- or 66-501 H&SS Senior Honors Thesis I (9 units)
- or 66-502 H&SS Senior Honors Thesis II (9 units)

Sample Schedule for B.A. in Economics

The sample schedule below is an illustration of how a student might plan their four-year schedule. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pick up additional degrees and/or study abroad. It is important for students to realize that degree requirements are actually the "minimum" set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman Fall

- 21-120 Differential and Integral Calculus (10 units)
- 36-201 Statistical Reasoning and Practice (9 units)

Sophomore Fall

- 73-240 Intermediate Macroeconomics (9 units)
- 73-450 Economics Colloquium (1 unit)

Junior Fall

- 73-310 Evolution of Economic Ideas and Analysis (9 units)
- 36-303 Sampling, Survey and Society (9 units)

Senior Fall

- 36-303 Sampling, Survey and Society (9 units)
- 73-497 Senior Project (9 units)

B.S. in Economics

The B.A. in Economics curriculum is designed to provide students with a deep understanding of economic theory and quantitative economic analysis. It is a goal of the degree program to have students develop an ability to observe and identify contemporary problems, and then provide solutions. In the advanced levels of the economic theory component degree, the foundations of modern economics are examined, using mathematically sophisticated models. The advanced data analysis component of the curriculum focuses on estimating economic relationships. The capstone of the curriculum is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies.

B.A. in Economics Curriculum

Mathematics Requirement (29 Units)

- 21-120 Differential and Integral Calculus (10 units)
- 21-122 Integration, Differential Equations and Approximation (10 units)
- 21-259 Calculus in Three Dimensions (9 units)
- or 21-256 Multivariate Analysis (9 units)

Sophomore Colloquium (1 Unit)

- 73-450 Economics Colloquium (1 unit)

Quantitative Analysis Requirements (27 Units)

- 36-225 Introduction to Probability Theory (9 units)
- or 36-217 Probability Theory and Random Processes (9 units)
or 21-225 Probability
36-226 Introduction to Statistical Inference 9
73-363 Econometrics 9

Writing Requirement (9 Units)
73-270 Writing for Economists 9

Economic Theory Requirements (39 Units)
73-100 Principles of Economics 9
73-252 Advanced Microeconomic Theory 6
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-253 Advanced Macroeconomic Theory 6

Advanced Economics Electives (45 Units)
Students must take five advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495. For the purpose of these requirements, the Undergraduate Economics Program may also designate as advanced electives courses from other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)
73-497 Senior Project 9
or 73-500 Tepper College Honors Thesis I
& 73-501 or Tepper College Honors Thesis II
or 66-501 H&SS Senior Honors Thesis I
& 66-502 and H&SS Senior Honors Thesis II

Sample Course Schedule for the B.S. in Economics
The sample schedule below is an illustration of how a student might plan their four-year schedule. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pick up additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actually the “minimum” set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman
Fall
21-120 Differential and Integral Calculus 10
21-125 Calculus in Three Dimensions 10
21-201 Statistical Reasoning and Practice 9
21-202 Statistical Methods 9
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-450 Economics Colloquium 9
73-405 Econometrics 9
73-363 Econometrics 9

Spring
21-122 Integration, Differential Equations and Approximation 9
36-226 Probability Theory 9
73-252 Advanced Microeconomic Theory 9
73-253 Advanced Macroeconomic Theory 9

Sophomore
Fall
21-120 Differential and Integral Calculus 10
21-125 Calculus in Three Dimensions 10
21-201 Statistical Reasoning and Practice 9
21-202 Statistical Methods 9
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-450 Economics Colloquium 9
73-405 Econometrics 9
73-363 Econometrics 9

Spring
36-226 Introduction to Statistical Inference 9
73-252 Advanced Microeconomic Theory 9
73-253 Advanced Macroeconomic Theory 9

Junior
Fall
73-363 Econometrics 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Spring
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Senior
Fall
73-363 Senior Project 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Spring
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

*In each semester, ----- represents courses (not directly required for the major).

B.S. in Economics and Mathematical Sciences
The B.S. in Economics and Mathematical Sciences is a collaborative effort between the Department of Mathematical Sciences and the Undergraduate Economics Program. Combining advanced mathematics with advanced economic theory is the hallmark of this curriculum. The curriculum provides students with courses that complement and develop depth of understanding of economic theory, applied economics, and applied mathematics. This degree offers an integrated curriculum, guiding students through a program of coursework that exploits and builds upon the synergies between mathematics and economics. This degree program equips students with the mathematical tools that are essential for success in Ph.D. programs in economics; mathematics; and key functional areas of business including finance, accounting, marketing, and information systems. Students pursuing this degree will be well prepared for the beginning of their research careers in academia, government, and industry. There are a limited number of student openings in this program; interested students may apply as early as their sophomore year.

B.S. in Economics and Mathematical Sciences Curriculum

Economic Theory Requirements (39 Units)
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6

Quantitative Analysis Requirements (36 Units)
36-225 Introduction to Probability Theory 9
or 36-217 Probability Theory and Random Processes 9
or 21-225 Probability 9
36-226 Introduction to Statistical Inference 9
36-401 Modern Regression 9
73-363 Econometrics 9

Mathematical Sciences Requirements (93 Units)
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations and Approximation 10
21-127 Concepts of Mathematics 10
21-228 Discrete Mathematics 9
21-241 Matrices and Linear Transformations 9
21-259 Calculus in Three Dimensions 9
21-260 Differential Equations I 9
21-355 Principles of Real Analysis I 9
21-356 Principles of Real Analysis II 9
21-373 Algebraic Structures 9
21-374 Introduction to Group Theory 9

Programming Requirement (9 Units)
15-110 Principles of Computing 10

Writing Requirement (9 Units)
73-270 Writing for Economists 9

Advanced Economic Electives (27 Units)
Students must take three advanced economics elective courses. Advanced Elective courses are those courses numbered 73-300 through 73-495, as well as courses designated by the Undergraduate Economics Program which are offered by other departments/programs. At least one of the courses must have Advanced Microeconomic Analysis or Advanced Macroeconomics Analysis as a prerequisite. Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability.

Recommended Advanced Economics Electives:
73-310 Evolution of Economic Ideas and Analysis 9
73-347 Game Theory for Economists 9
73-392 Financial Economics 9
73-405 Introduction to Dynamic Economics 9

Mathematical Science Depth Electives (27 Units)
Students must take three advanced mathematics depth courses. Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability.

Recommended Mathematical Science Depth Electives:
21-292 Operations Research I 9
21-329 Set Theory 9
21-365 Projects in Applied Mathematics 9
21-366 Topics in Applied Mathematics 9
21-372 Functions of a Complex Variable 9
21-374 Field Theory 9

The sample schedule below is an illustration of how a student might plan their four-year schedule. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pick up additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actually the “minimum” set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman
Fall
21-120 Differential and Integral Calculus 10
21-125 Calculus in Three Dimensions 10
21-201 Statistical Reasoning and Practice 9
21-202 Statistical Methods 9
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-450 Economics Colloquium 9
73-405 Econometrics 9
73-363 Econometrics 9

Spring
21-122 Integration, Differential Equations and Approximation 9
36-226 Probability Theory 9
73-252 Advanced Microeconomic Theory 9
73-253 Advanced Macroeconomic Theory 9

Sophomore
Fall
21-120 Differential and Integral Calculus 10
21-125 Calculus in Three Dimensions 10
21-201 Statistical Reasoning and Practice 9
21-202 Statistical Methods 9
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-450 Economics Colloquium 9
73-405 Econometrics 9
73-363 Econometrics 9

Spring
36-226 Introduction to Statistical Inference 9
73-252 Advanced Microeconomic Theory 9
73-253 Advanced Macroeconomic Theory 9

Junior
Fall
73-363 Econometrics 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Spring
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Senior
Fall
73-363 Senior Project 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

Spring
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9
Economics Elective 9

*In each semester, ----- represents courses (not directly required for the major).
The Major in Economics and Statistics

Faculty Advisor: Rebecca Nugent
Office: Baker Hall 132A
Email: acadcoord@stat.cmu.edu

The major in economics and statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major’s curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

The requirements for the B.S. in Economics and Statistics are the following:

I. Prerequisites 66/76 units

Course List

1. Mathematical Foundations 39 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-222</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-240</td>
<td>Matrix Algebra with Applications</td>
<td>10</td>
</tr>
<tr>
<td>or 21-241</td>
<td>Matrices and Linear Transformations</td>
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</tr>
</tbody>
</table>

2. Economics Foundations 9 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>73-250</td>
<td>Principles of Economics</td>
<td>9</td>
</tr>
</tbody>
</table>

3. Statistical Foundations 18 units

Course List

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>and one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>36-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

**Students who enter the program with 36-225/226 should discuss options with their advisors**

II. Disciplinary Core 120/129 units

1. Economics Core 48 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>73-252</td>
<td>Advanced Microeconomic Theory</td>
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</tr>
<tr>
<td>73-230</td>
<td>Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240</td>
<td>Intermediate Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-253</td>
<td>Advanced Macroeconomic Theory</td>
<td>6</td>
</tr>
<tr>
<td>73-270</td>
<td>Writing for Economists</td>
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</table>

*Mini Courses

2. Statistics Core 36 units

<table>
<thead>
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<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
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</tr>
<tr>
<td>or 36-217</td>
<td>Probability Theory and Random Processes</td>
<td>9</td>
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<tr>
<td>or 21-325</td>
<td>Probability</td>
<td>9</td>
</tr>
<tr>
<td>36-226</td>
<td>Introduction to Statistical Inference</td>
<td>9</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
<td>9</td>
</tr>
<tr>
<td>36-402</td>
<td>Advanced Data Analysis</td>
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</tbody>
</table>

*In order to be a major in good standing, a grade of C or better is required in 36-225 (or equivalents), 36-226 and 36-401. Otherwise you will not be allowed to continue in the major.

Advanced Electives 45 units

Students must take two advanced economics elective courses (numbered 73-300 through 73-495) and two advanced statistics elective courses (numbered 36-300 through 36-495). A fifth advanced elective is required and can be chosen from either statistics or economics.

Total number of units for the major 195 units

Total number of units for the degree 360 units

Sample Program

The following sample program illustrates one way to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see footnotes below the schedule).

Freshman Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
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<td>21-222</td>
<td>Integration, Differential Equations and Approximation</td>
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<td>21-256</td>
<td>Multivariate Analysis</td>
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<tr>
<td>or 21-259</td>
<td>Calculus in Three Dimensions</td>
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<td>21-240</td>
<td>Matrix Algebra with Applications</td>
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</tr>
<tr>
<td>or 21-241</td>
<td>Matrices and Linear Transformations</td>
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</table>

Sophomore Fall

<table>
<thead>
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<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
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<tr>
<td>21-123</td>
<td>Integration, Differential Equations and Approximation</td>
<td></td>
</tr>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>and one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>36-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

Sophomore Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-240</td>
<td>Intermediate Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-252</td>
<td>Advanced Microeconomic Theory</td>
<td>6</td>
</tr>
<tr>
<td>73-253</td>
<td>Advanced Macroeconomic Theory</td>
<td>6</td>
</tr>
<tr>
<td>73-270</td>
<td>Writing for Economists</td>
<td>9</td>
</tr>
<tr>
<td>73-363</td>
<td>Econometrics</td>
<td>9</td>
</tr>
</tbody>
</table>

Junior Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-260</td>
<td>Differential Calculus</td>
<td>10</td>
</tr>
<tr>
<td>73-270</td>
<td>Writing for Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-363</td>
<td>Econometrics</td>
<td>9</td>
</tr>
<tr>
<td>or 21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
</tbody>
</table>

Senior Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-228</td>
<td>Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-229</td>
<td>Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-373</td>
<td>Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
<td>9</td>
</tr>
</tbody>
</table>

*In each semester, ----- represents courses (not directly required for the major). Please note that students pursuing the B.S. in Mathematical Sciences and Economics must fulfill the Mellon College General Education requirements and not the Dietrich College General Education requirements.
Supplemental Programs

Honors Program in Economics

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. For more information, consult the Dietrich Honors Program website (http://www.hss.cmu.edu/departments/deans_office/aac/honors).

The Tepper Senior Honors Program in Economics (http://tepper.cmu.edu/undergraduate-economics/curricula/tepper-senior-honors-program-in-economics) provides qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. The primary rewards of participating in the Honors Program in Economics are three-fold. First comes the satisfaction of undertaking and completing an original piece of research. Working independently or with a faculty member to identify a research question and claim ownership of its discovery process is a rewarding experience. Second is the opportunity to challenge oneself intellectually. The third advantage is the opportunity to graduate with Tepper Honors. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience.

Students are invited into the Tepper Senior Honors Program in Economics during their junior year. Invitation is based on academic achievement at Carnegie Mellon University, ability to work independently, and tenacity of spirit. In addition to writing an honors thesis, requirements for this program include: an approved selection of upper-level economic electives which include a minimum of two courses requiring Advanced Microeconomic Analysis and/or Advanced Macroeconomic Analysis as pre-requisites and participation in the Senior Honors Research in Economics Colloquium.

Accelerated Master’s Degree Programs


Preparation for Ph.D. Programs

The Undergraduate Economics Program has been successful in preparing students for admission into the nation’s most competitive doctoral programs. Students interested in pursuing a career in research are encouraged to meet with the Director of the Undergraduate Economics Program early in their undergraduate careers.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree completing all of the requirements for the B.S. in Economics or the B.S. in Economics and Statistics. In addition, the student’s total units complete must be at least 90 units in excess of the requirement for the student’s other degree(s) or with a B.S. in whichever is greater. Interested students should meet with an economics advisor.

Additional Major in Economics Curriculum

All university students are eligible to pursue an additional major in economics in conjunction with a major in any department in the university other than economics. The requirements for the Additional Major in Economics are the same as those for the B.S. in Economics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics are typically asked to take additional advanced economics electives.

Additional Major in Economics and Statistics Curriculum

All university students are eligible to pursue a major in economics and statistics in conjunction with a major in any department in the university other than statistics or economics. The requirements for the Additional Major in Economics in Statistics are the same as those for the B.S. in Economics and Statistics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics and Statistics are typically asked to take additional advanced economics or statistics electives.

Minor in Economics

The Minor in Economics degree program provides students with a solid understanding of economic theory and data analysis.

All university students are eligible to pursue the Minor in Economics in conjunction with a major in any other department in the university. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements (19 Units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
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</tbody>
</table>

Economic Theory Requirements (27 Units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230</td>
<td>Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240</td>
<td>Intermediate Macroeconomics</td>
<td>9</td>
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</tbody>
</table>

Quantitative Analysis Requirements (27 Units)

<table>
<thead>
<tr>
<th>Option</th>
<th>Course Code</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option One</td>
<td>36-203</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>23-325</td>
<td></td>
</tr>
<tr>
<td></td>
<td>36-207</td>
<td></td>
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<tr>
<td></td>
<td>36-217</td>
<td></td>
</tr>
<tr>
<td></td>
<td>36-220</td>
<td></td>
</tr>
<tr>
<td>Option Two</td>
<td>36-201</td>
<td>9</td>
</tr>
</tbody>
</table>

*Courses may elect not to take 73-240 Intermediate Macroeconomics, and instead, replace it with an additional advanced economics elective.*
Advisors for the Undergraduate Economics Program are designated by the program offered by other departments/programs. Additionally, students may work with their economics advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Minor in Innovation, Economics, and Entrepreneurship

Innovation (both technological and social) and entrepreneurship are the catalytic forces behind modern economic growth. Today, both developing and developed countries are looking for ways to promote and sustain growth. This minor builds on study of the behavior of individuals and firms to foster an understanding of how organizations manage innovation and learning, how firms and the market respond to technological change, and how entrepreneurs are able to turn ideas into goods and services and new markets.

All university students are eligible to pursue the Minor in Innovation, Economics, and Entrepreneurship in conjunction with any major in the university. The curriculum consists of six courses (54-57 units) of which five core courses are required and the sixth course (an elective) may be chosen from a list of options from across the University.

In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 21-259 Calculus in Three Dimensions</td>
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</table>

Required Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-415 Introduction to Entrepreneurship</td>
<td>9</td>
</tr>
<tr>
<td>70-437 Organizational Learning and Knowledge Management</td>
<td>9</td>
</tr>
<tr>
<td>70-438 Commercialization and Innovation</td>
<td>9</td>
</tr>
<tr>
<td>73-465 Technology Strategy</td>
<td>9</td>
</tr>
<tr>
<td>73-407 Fundamentals of Statistical Modeling</td>
<td>9</td>
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</tbody>
</table>

Note: Students who have completed 73-363 or 36-401 are exempted from 73-407.

Electives*

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-320 Social Web</td>
<td>12</td>
</tr>
<tr>
<td>08-533 Privacy, Policy, Law and Technology</td>
<td>9</td>
</tr>
<tr>
<td>73-315 Market Design</td>
<td>9</td>
</tr>
<tr>
<td>73-440 Auctions and Markets</td>
<td>9</td>
</tr>
<tr>
<td>73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property</td>
<td>9</td>
</tr>
</tbody>
</table>

This is not an exhaustive list of qualifying courses. In particular, the graduate courses from Heinz College, Human Computer Interaction, Information Networking Institute, and Institute for Software Research which are open to the Minor in Innovation, Economics, and Entrepreneurship students are not presented. The complete list of eligible may be found on the Undergraduate Economics Program website.

Academic Standards and Policies

Undergraduate economics students are in the unique position of belonging to two CMU colleges, Marianna Brown Dietrich College of Humanities and Social Sciences and the Tepper School of Business. To find a detailed description of policies governing economics students, please consult the Undergraduate Economics Program’s handbook.

Faculty

LAURENCE ALES, Assistant Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2008–. STEPHEN M. CALABRESE, Visiting Associate Professor of Economics, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

KAREN B. CLAY, Associate Professor of Economics and Public Policy, H. J. Heinz III College – Ph.D., Stanford University; Carnegie Mellon, 1998–.

ROBERT M. DAMMON, Associate Dean, Education; Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1984–.

TIMOTHY P. DERDENER, Assistant Professor of Economics and Strategy – Ph.D., University of Southern California; Carnegie Mellon, 2009–.

KENNETH B. DUNN, Dean; Professor of Financial Economics – Ph.D., Purdue University; Carnegie Mellon, 1979–.

DENNIS N. EPPLE, Thomas Lord Professor of Economics; Head, Economics Programs – Ph.D., Princeton University; Carnegie Mellon, 1974–.

MARIA MARTA FERREYRA, Associate Professor of Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 2002–.

CHRISTINA FONG, Senior Research Scientist in Social and Decision Sciences, College of Humanities and Social Sciences – Ph.D., University of Massachusetts, Carnegie Mellon, 2001–.

JOACHIM RYOEHI GROEGER, Assistant Professor of Economics – Ph.D., London School of Economics; Carnegie Mellon, 2010–.

ISA E. HAFALIR, Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.

BURTON HOLLIFIELD, Professor of Financial Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999–.

KARIN KANG, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Pennsylvania; Carnegie Mellon, 2012–.

ONYUR KESTEN, Associate Professor of Economics – Ph.D., University of Rochester; Carnegie Mellon, 2005–.


LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics; University Professor; Director, Green Design Institute; Co-Director, Carnegie Mellon Electricity Industry Center – Ph.D., Harvard University; Carnegie Mellon, 1963–.

REBECCA LESSEM, Assistant Professor of Economics – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–.

BENNETT H. MCCALLUM, H. J. Heinz Professor of Economics – Ph.D., Rice University; Carnegie Mellon, 1981–.

ALLAN H. MELTZER, The Allan H. Meltzer University Professor of Political Economy – Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957–.


CHRISTOPH MUELLER, Assistant Professor of Economics – Ph.D., University of Michigan; Carnegie Mellon, 2010–.

JOHN R. O'BRIEN, Associate Professor of Accounting and Experimental Economics – Ph.D., University of Minnesota; Carnegie Mellon, 1984–.

NICOLAS PETROSKY-NADEAU, Assistant Professor of Economics – Ph.D., University of Quebec; Carnegie Mellon, 2009–.

DUANE J. SEPP, BNY Mellon Professor of Finance; Head, Master of Science in Computational Finance – Ph.D., University of Chicago; Carnegie Mellon, 1986–.
PATRICK W. SILEO, Associate Teaching Professor of Economics and Finance - Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999–.

CHRISTOPHER SLEET, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

FALLAW B. SOWELL, Associate Professor of Economics – Ph.D., Duke University; Carnegie Mellon, 1988–.

CHESTER S. SPATT, Pamela R. and Kenneth B. Dunn Professor of Finance; Director, Center for Financial Markets – Ph.D., University of Pennsylvania; Carnegie Mellon, 1979–.

STEPHEN E. SPEAR, Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1982–.

CHRISTOPHER I. TELMER, Associate Professor of Financial Economics – Ph.D., Queen’s University (Canada); Carnegie Mellon, 1992–.

SEVIN YELTEKIN, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

MEHMET B. YENMEZ, Assistant Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2010–.

ARIEL ZETLIN-JONES, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Minnesota; Carnegie Mellon, 2012–.

Visiting Faculty

ANNELEIS DEUSS, Visiting Assistant Professor of Economics – Ph.D., Cornell University; Carnegie Mellon, 2010–.

Adjunct Faculty

CAROL B. GOLDBURG, Director, Undergraduate Economics Program; Adjunct Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–.

ELIF INCEKARA HAFALIR, Adjunct Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.

FREDERICK H. RUETER, Adjunct Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1998–.
Department of English

Majoring in English: The Four English Degree Options

All students who major in English choose one of the four majors offered by the department as the main focus of their studies:

- The B.A. in English
- The B.A. in Creative Writing
- The B.A. in Professional Writing
- The B.S. in Technical Writing & Communication

Other Options for English Majors

Students who wish to broaden their experience with English courses may do so by taking more than the minimum requirements for each major or by combining two of the majors within the department for a double major in English. Common combinations include Professional Writing and Creative Writing, Creative Writing and the B.A. in English, or the B.A. in English and Professional Writing. Students who are already majoring in one of the English degrees can generally add a second English major by completing additional courses. Consult the English Department and the section below on "Completing an Additional Major in English" for further detail.

All of the English majors may also be combined with majors and minors from other Carnegie Mellon departments and colleges. English Department advisors can help you to explore the available options and to choose a major or combination of programs that is appropriate for your interests and goals.

How the Curriculum is Structured

In addition to Dietrich College requirements, English majors complete 11 to 12 courses (99 to 114 units) specifically related to their chosen major within English and structured as indicated below. Please note that courses taken to fulfill requirements in other major or minor programs may not be applied to requirements for any of the English Department majors or minors.

Core Requirements for the Specific Major (7 to 9 courses, 63 to 81 units)
Complete seven to nine courses.

The Core Requirements differ for each major and are designed explicitly to provide both breadth and depth within the specific major the student has chosen.

English Electives (3 to 4 courses, 27 to 36 units)
Complete three to four elective courses.

Elective Courses for the major are designed to add breadth to each student’s study within English and to provide experience with the range of approaches to reading and writing available within the department. Students in all English majors are encouraged to sample widely from the Department’s offerings.

The B.A. in English

An important role of English departments has been to create interpretations of the literature of various historical periods, including the present. The B.A. in English (EBA) at Carnegie Mellon builds on, and also extends, this tradition by teaching texts as part of a complex web of historical conditions and relationships; by teaching both major literary texts and public and non-fiction documents; and by teaching film, television, and other storytelling media alongside more conventional texts.

The B.A. in English is distinctive in drawing from the artistic and research strengths of the Department’s faculty in Literary and Cultural Studies, Rhetoric, and Creative Writing. Literary and Cultural Studies focuses on the way texts are formally constructed and how they function in historical and contemporary contexts. Creative Writing helps students focus on language as a tool to explore and depict experience. Rhetoric focuses on the principles through which writers construct texts and audiences respond to them. Drawing from all of these perspectives, students in the B.A. in English learn the research skills and writing strategies to enable them to analyze the language and texts of other writers and to report their research in effective texts of their own. Such training can prepare students for graduate work in literature, cultural studies, or rhetoric, and also for careers in law, business,
or government, which require similar skills in interpretation, research, and writing.

The 200-level core courses are designed to introduce students to writing in a variety of genres, to a knowledge of literary and other media forms, and to a basic theoretical knowledge of how texts are produced and interpreted. In the Interpretive Practices course, students are introduced to basic concepts, methods, and practices of literary and rhetorical approaches to texts. In the Survey of Forms course, students learn how to use language to express experience through poetic and narrative forms.

In addition to these courses, students take at least one course in rhetoric, two 300-level EBA core courses, and two 400-level seminars designed to introduce them to the functioning of texts within specific cultural and rhetorical contexts. Two of 300- and 400-level courses must feature a specific historical period, and one of these "period" courses must have a pre-1900 focus. Period study introduces students to a range of historical and cultural texts and to a range of methods for analyzing these texts in their original context and across contexts. Courses that fulfill the Rhetoric Requirement focus explicitly on language and discourse as objects of study and emphasize the relationships of language, text structure, and meaning within specific contexts.

Interpretive Practices (76-294) and Research in English (76-394) are required of students in the B.A. in English. Interpretive Practices grounds students in literary and cultural theory and trains them in writing interpretations of texts. Research in English offers training in gathering information systematically and in building arguments based on that information. Students will hone their skills in reading texts, using critical commentary, assessing print and electronic materials, and conducting interviews and surveys. They will learn how to test their hypotheses against alternatives and present their research to audiences within the discipline of English. The historical or thematic content of this course will vary from one semester to another. While 76-394 is not a pre-requisite for 400-level courses, it is strongly recommended that EBA majors take this course in their junior year. At the advanced level EBA majors are required to take two 400-level seminars for which Interpretive Practices (76-294) is a prerequisite.

EBA majors also complete three English Electives, one at the 200 or above level and two at the 300 or 400 level. Electives at the 200 level allow students to sample introductory courses in special topics – such as gender and media studies — within rhetorical, literary, and cultural studies, or genre courses in the novel or comedy. Electives at the 300 and 400 level encourage students to explore more advanced study in the various offerings within the department. In choosing their electives, EBA students are encouraged to sample courses from across the department.

Curriculum

In addition to satisfying all of the Dietrich College degree requirements for B.A. candidates, English B.A. majors must complete 11 courses in the following areas:

**EBA Core (8 courses, 72 units)**

Complete both courses:

- **76-26x** Survey of Forms (Nonfiction, Fiction, Poetry, or Screenwriting)
- **76-294** Interpretive Practices

Complete six required courses.

1. **Research Course (1 course, 9 units)**
   - 76-394 Research in English

2. **Rhetoric Requirement (1 course, 9 units)**
   - Complete one course from a set of varied offerings in Rhetoric as designated each term by the English Department. Rhetoric courses focus explicitly on language and discourse as objects of study and emphasize the relationships of language, text structure, and meaning within specific contexts.

3-4. **300-level Courses (2 courses, 18 units)**

Complete two 300-level courses that investigate the production and interpretation of texts and other media from a variety of periods and theoretical and methodological perspectives. Course offerings that meet these requirements are advertised on a semester-by-semester basis. For EBA majors, 76-294 Interpretive Practices is a prerequisite for these courses. Course options include but are not limited to the following:

- 76-330 Medieval Literature
- 76-331 Renaissance Literary and Cultural Studies
- 76-332 African American Literature
- 76-335 20th Century Literary and Cultural Studies
- 76-339 Advanced Film and Media Studies
- 76-347 American Literary and Cultural Studies: Contemporary Fiction
- 76-386 Language & Culture

5-6. **400-level Seminar Courses (2 courses, 18 units)**

Complete two 400-level seminar courses which investigate a specific topic in depth and allow students to work on a major research-based paper. Courses in this category will be advertised on a semester-by-semester basis. For EBA majors, Interpretive Practices (76-294) is a prerequisite and Research in English (76-394) is pre- or co-requisite. Among current course offerings, examples include but are not limited to the following:

- 76-431 Chaucer
- 76-439 Advanced Seminar in Film and Media Studies
- 76-451 Topics in Language Study
- 76-457 Topics in Rhetoric
- 76-476 Rhetoric of Science
- 76-482 Comparative Rhetoric

**“Period” Course Requirement**

The period course requirement is not a separate course requirement per se but one that needs to be met through the selection of the required 300- and 400-level courses. At least two of these four required courses must be "period" courses, that is, courses that focus on texts that are connected in time and place or through common social concerns. One of these two courses must focus on a historical period prior to 1900. Courses in this category will vary from year to year and be advertised on a semester-by-semester basis. Such courses may be at either the 300 or 400 level.

**English Electives (3 courses, 27 units)**

Complete three courses from the English Department’s offerings. One may be at the 200 level or above; the remaining two must be at the 300 or 400 level. Electives may include any courses offered by the English Department with the exception of courses designed for non-majors. Some semester offerings may include cross-listed courses from Modern Languages or History.

**English B.A. Sample Curriculum**

As a department, we recommend beginning the major in the sophomore year if possible. Students in Dietrich College may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall. Interpretive Practices (76-294) should generally be taken in the sophomore year and before Research in English (76-394).

**Sophomore Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>76-294 Interpretive Practices</td>
<td>76-26x Survey of Forms (9 units)</td>
</tr>
<tr>
<td>76-394 Research in English</td>
<td>76-3xx/4xx Rhetoric Course (9 units)</td>
</tr>
<tr>
<td>76-3xx/4xx English Elective</td>
<td>76-xx/x/3xx/4xx English Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
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<tr>
<td>Elective</td>
<td>Elective</td>
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**Junior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-xx/4xx 400-level Seminar**</td>
<td>76-4xx 400-level Seminar**</td>
</tr>
<tr>
<td>76-3xx 300-level EBA Course*</td>
<td>76-3xx/4xx English Elective</td>
</tr>
<tr>
<td>76-3xx/4xx English Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
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<tr>
<td>Elective</td>
<td>Elective</td>
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</tbody>
</table>

* Interpretive Practices (76-294) is a prerequisite for 300-level EBA courses

**Interpretive Practices (76-294) is a prerequisite and Research in English (76-394) is a pre- or co-requisite for 400-level seminars.**
The B.A. in Creative Writing

Carnegie Mellon is one of a small number of English departments in the country where undergraduates can major in Creative Writing. In the Creative Writing major (CW), students develop their talents in writing fiction, poetry, screenwriting, and creative nonfiction. While studying with faculty members who are writers, Creative Writing majors read widely in literature, explore the resources of their imaginations, sharpen their critical and verbal skills, and develop a professional attitude toward their writing. Students also have the opportunity to work with nationally known poets and fiction writers through the department’s Visiting Writers series. The CW program is made up of faculty and students who have an intense commitment to their work. Students who do not exhibit a high level of commitment and promise in the introductory classes will not be encouraged to continue in the major.

Beginning with the Dietrich College requirements, the curriculum for Creative Writing majors is designed to broaden the students’ intellectual backgrounds and encourage their analytical abilities. English courses beyond the Creative Writing core requirements provide additional practice in the careful reading, writing and understanding of literary texts.

Students in the Creative Writing major are required to take two of the introductory Survey of Forms courses, ideally in their sophomore year. Choices include Survey of Forms: Poetry (76-265), Survey of Forms: Fiction (76-260), Survey of Forms: Screenwriting (76-269), and Survey of Forms: Creative Nonfiction (76-261). In order to proceed into the upper level courses in the major (and in the arts of the genres), students must do well in these introductory courses (receive a grade of A or B). In their junior and senior years, Creative Writing majors take four workshops in fiction, poetry, screenwriting, or nonfiction. At least two of the workshops must be taken in a single genre. In the writing workshops, students develop their critical and verbal abilities through close writing and analysis of poems, stories, and other literary forms. Their work is critiqued and evaluated by peers and the faculty. Students may write a Senior Project or Honors Thesis (if they qualify for Dietrich College honors) under the supervision of a faculty member during their senior year.

Carnegie Mellon also offers Creative Writing majors various extracurricular opportunities for professional development. For example, they may work as interns with the Carnegie Mellon University Press, which is housed in the English Department. The Press publishes scholarly works, and books of poetry and short stories by both new and established American writers. Students may help edit and submit their work for publication to The Oakland Review, a Carnegie Mellon University-sponsored annual journal, and Dossier, the literary supplement to The Tartan (the student newspaper). Students also have opportunities to read their works in a series of readings by student writers held in the Gladys Schmitt Creative Writing Center and to hear nationally known authors as part of the Carnegie Mellon Visiting Writers series. Additionally, the English Department (in cooperation with the Carnegie Mellon University Press) offers prizes for students each year in the writing of fiction, non-fiction, poetry and screenwriting. These include the Pauline Adamson Awards, the Academy of American Poets Prize, the Carnegie Mellon University Press Prizes in poetry and fiction, the Family Friendly Programming Forum Scholarships in Film, and the Topol Award in Creative Writing/Fiction. In addition, the Gladys Schmitt Scholarship Fund and the Gladys Schmitt Student Enhancement Fund provide support for creative writing majors to attend writing conferences and festivals.

Because the Creative Writing program provides a disciplined atmosphere in which to study and write, it appeals especially to students who are as concerned with their personal growth as with vocational goals. Nevertheless, the extracurricular writing activities and a variety of writing internships available on and off campus can provide Creative Writing majors with valuable experiences for planning their future. After graduation, many Creative Writing majors go on to graduate writing programs and to careers in teaching, publishing, public relations, advertising, TV and film, or freelance writing and editing.

Curriculum

In addition to satisfying all of the Dietrich College degree requirements for B.A. candidates, Creative Writing majors must complete 11 courses in the following areas:

Creative Writing Core (7 courses, 63 units)

Two Survey of Forms Courses (2 courses, 18 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-260</td>
<td>Survey of Forms: Fiction</td>
<td>9</td>
</tr>
<tr>
<td>76-261</td>
<td>Survey of Forms: Creative Nonfiction</td>
<td>9</td>
</tr>
<tr>
<td>76-265</td>
<td>Survey of Forms: Poetry</td>
<td>9</td>
</tr>
<tr>
<td>76-269</td>
<td>Survey of Forms: Screenwriting</td>
<td>9</td>
</tr>
</tbody>
</table>

* A student must receive a grade of A or B in the Survey of Forms class in a specific genre in order to be eligible to enroll in a workshop of that genre. A student who receives a grade of C in a Survey of Forms course may enroll in a related workshop only with the permission of the workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

One Reading in Forms Course (1 course, 9 units)

Complete one of the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-362</td>
<td>Reading in Forms: Nonfiction</td>
<td>9</td>
</tr>
<tr>
<td>76-363</td>
<td>Reading in Forms: Poetry</td>
<td>9</td>
</tr>
<tr>
<td>76-364</td>
<td>Readings in Forms: Fictions</td>
<td>9</td>
</tr>
</tbody>
</table>

Four Creative Writing Workshops (4 courses, 36 units)

Complete four Creative Writing workshops, at least two in a single genre. Workshops in all genres may be taken more than once for credit.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-365</td>
<td>Beginning Poetry Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-460</td>
<td>Advanced Fiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-462</td>
<td>Advanced Fiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-464</td>
<td>Creative Nonfiction Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-465</td>
<td>Advanced Poetry Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-469</td>
<td>Advanced Screenwriting Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-4xx</td>
<td>Elective Workshops (various forms)</td>
<td>9</td>
</tr>
</tbody>
</table>

English Electives (4 courses, 36 units)

Complete four additional courses from the English Department’s offerings. Two of the four English Electives must be courses that are designated as fulfilling the literature requirement and focus on close reading of literary texts. Please consult the list of courses published each semester by the Department for current offerings. English Electives may include any course offered by the Department. Additionally, English Electives can include no more than one course at the 200 level. The remaining English Electives must be at the 300 or 400 level. In choosing Electives, students are encouraged to sample courses from across the Department.

Creative Writing B.A. Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in Dietrich College may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td>76-26x Survey of Forms</td>
<td>76-26x Survey of Forms</td>
</tr>
<tr>
<td></td>
<td>76-36x Reading in Forms</td>
<td>76-3xx/4xx Creative Writing Workshop</td>
</tr>
<tr>
<td></td>
<td>76-xx/3xx/4xx English Elective</td>
<td>76-xx/3xx/4xx English Elective</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

The B.A. in Professional Writing

Professional Writing combines liberal and professional education with a strong foundation in rhetorical studies. While based firmly in the liberal arts tradition, the major has a strong career orientation and is specifically designed to prepare students for successful careers as writers and communications specialists in a range of fields: publishing, government, journalism, the non-profit sector, education, public and media relations, corporate communications, advocacy writing, and the arts. The major is designed to develop articulate and reflective communications professionals with both the skills needed to enter and negotiate current work contexts (including writing for the web and for other digital media) and the analytic and problem-solving skills needed to understand and keep pace with cultural and technological change.

The Professional Writing major includes 12 courses: 9 PW Core Requirements and 3 English Electives. The 9 Core Requirements include foundations courses in writing (professional, technical & creative), style & editing, and argument plus a cluster of advanced rhetoric, language studies, and specialized writing courses, all designed to closely integrate analysis and production. Through special topics courses—journalism, on-line information design, advocacy writing, document design for print, science writing, public relations and corporate communications, writing for multimedia—students can pursue specialties while working with faculty who are both experts and practicing professionals in these fields. PW majors also gain experience in working on team- and client-based projects and receive focused support to develop a portfolio of polished writing samples to use in applying for
internships and employment. Through English Electives in Rhetoric, Creative Writing, and Literary and Cultural Studies, students gain additional practice in the careful reading, writing, and analysis of both literary and non-fictional texts and important insights into how texts function in their historical and contemporary contexts. As a capstone experience, senior PW majors have the opportunity to complete a Senior Project or, upon invitation from the college, a Senior Honors Thesis in Rhetoric or Professional Writing. PW students can also apply for Student Undergraduate Research Grants (SURG) or summer fellowships (SURF) to work on independent research projects with department faculty.

While the major appeals to students with strong professional interests, both core and elective requirements develop the broad intellectual background one expects from a university education and prepare students to either enter the workplace or pursue graduate study in fields as diverse as communications, law, business, and education. PW majors also have the opportunity to apply for the Department’s accelerated MA in Professional Writing, the MAPW 4+1, which allows them to complete the degree in 2 semesters instead of the usual 3. As they choose elective courses, minors, additional majors beyond the Department, Professional Writing majors are encouraged to explore courses from across the university, keeping in mind the very important point that to be effective, writers must have both strong writing skills and in-depth knowledge of the subjects that they write about. While there is no formal requirement for these elective courses, students are encouraged to think about what courses will complement their interest in Professional Writing. Students interested in journalism, for example, are encouraged to take courses in history and political science, while those interested in writing for health-related fields are pointed toward courses in biology, chemistry, and healthcare policy. Other possible elective areas include but are not limited to business, organizational behavior, graphic design, the arts, psychology, economics, modern languages, ethics, and public policy, and computer programming. Because the major in Professional Writing is deliberately structured as a flexible degree that allows a broad range of options, majors in Professional Writing should consult closely with their English Department advisors on choosing both elective and required courses and in planning for internships and summer employment.

Various opportunities for writers to gain professional experience and accumulate material for their writing portfolios are available through campus publications, department-sponsored internships for academic credit, and writing-related employment on and off campus. Professional Writing majors frequently write for The Tartan, the student-run campus newspaper, and have served as editor-in-chief, section editors, and reporters for both the main paper the Pillbox section on arts, events, and popular culture. PW majors serve similar roles on the undergraduate research journal, Thought; the editorial staff of The Oakland Review, a Carnegie Mellon undergraduate literary journal; and The Triple Helix, and international undergraduate journal of science, society, and law, which has an active chapter on the Carnegie Mellon campus. PW majors have also conceived and developed independent publishing projects to fill perceived needs on and beyond campus. Within the last several years, for example, PW majors founded The Cut, an independent magazine focusing on music, and d’Arte, a magazine with a focus on the arts, particularly design and fashion. These publications provide valuable opportunities for students to put their own written work to gain experience in skills ranging from editing, to layout, to production, to selling ads or managing business affairs. Students can also write for the faculty and staff newspaper, Focus, under the guidance of the editor, or take a course in editing and publishing with the Carnegie Mellon University Press. Additionally, the English Department offers student awards in Professional Writing each year. The awards are judged by professionals outside the university and include the Pauline Adamson Awards in nonfiction and the Dawe Memorial Award to encourage creativity and innovation in publishing. The Dawe Award provides a junior in the department with a $2000 grant to plan, produce, and publish an innovative magazine, newspaper, or other periodical publication.

Professional Writing majors have the option of taking writing internships for academic credit during their junior or senior year and are also strongly encouraged to seek professional internships throughout their undergraduate years and during their summers. Opportunities in public and media relations, newspaper and magazine writing, healthcare communication, publishing, technical writing, public service organizations, and writing for the web and new media illustrate both internship possibilities and the kinds of employment that Professional Writing majors have taken after graduation. In addition to providing professional experience, these internships help students establish contacts outside the University and add professional publications to their portfolios. Recent academic year and summer internships have included non-profit organizations such as The Museum of Fine Arts Boston, the West Penn Pen Hospital Foundation, and the Pittsburgh Symphony; traditional and new media PR and information; and professional contexts. Courses emphasize the relationships between texts and their contexts and pay particular attention to textual features, meaning, processes of reading and writing, and the ways in which language practices vary over time and across situations and cultures. The courses also equip students with explicit techniques for analyzing, understanding, and exploring language practices. Rhetoric courses may also be taken as part of a PW major’s requirements for 4 advanced Writing/Rhetoric courses and include but are not limited to the following list.

### Rhetoric/Language Studies Requirement

1. Complete one course from designated Rhetoric courses offered and advertised each semester by the Department. Rhetoric courses focus on understanding the role of language and language practices in both personal and professional contexts.
2. Courses emphasize the relationships between texts and their contexts and pay particular attention to textual features, meaning, processes of reading and writing, and the ways in which language practices vary over time and across situations and cultures.
3. The courses also equip students with explicit techniques for analyzing, understanding, and exploring language practices.
4. Rhetoric courses may also be taken as part of a PW major’s requirements for 4 advanced Writing/Rhetoric courses and include but are not limited to the following list.

#### Rhetoric Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-318</td>
<td>Communicating in the Global Marketplace</td>
<td>9</td>
</tr>
<tr>
<td>76-319</td>
<td>Environmental Rhetoric</td>
<td>9</td>
</tr>
<tr>
<td>76-355</td>
<td>Leadership, Dialogue, and Change</td>
<td>9</td>
</tr>
<tr>
<td>76-378</td>
<td>Literacy: Educational Theory and Community Practice</td>
<td>9</td>
</tr>
<tr>
<td>76-385</td>
<td>Introduction to Discourse Analysis</td>
<td>9</td>
</tr>
<tr>
<td>76-386</td>
<td>Language &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>76-387</td>
<td>Narrative &amp; Argument</td>
<td>9</td>
</tr>
<tr>
<td>76-389</td>
<td>Rhetorical Grammar</td>
<td>9</td>
</tr>
<tr>
<td>76-419</td>
<td>Communication Revolutions &amp; Technologies</td>
<td>9</td>
</tr>
<tr>
<td>76-420</td>
<td>Process of Reading and Writing</td>
<td>9</td>
</tr>
<tr>
<td>76-451</td>
<td>Topics in Language Study</td>
<td>9</td>
</tr>
<tr>
<td>76-457</td>
<td>Topics in Rhetoric</td>
<td>9</td>
</tr>
<tr>
<td>76-476</td>
<td>Rhetoric of Science</td>
<td>9</td>
</tr>
<tr>
<td>76-491</td>
<td>Rhetorical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>76-492</td>
<td>Rhetoric of Public Policy</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Advanced Writing/Rhetoric Courses

1. PW majors complete four Advanced Writing/Rhetoric courses at the 300- or 400-level. Options for these courses include all of the rhetoric courses listed above plus the writing-focused courses listed below.
2. Additional courses that fulfill these requirements are advertised on a semester-by-semester basis.
3. For help in choosing which of the possible options are most appropriate for various professional goals – journalism, writing for new media, editing and publishing, public relations/corporate communications, or science and technical writing – consult your English Department advisor and the “Selected Core Courses & Electives for PW Majors” advising sheet available through the English Department.
4. All PW majors, regardless of their career focus, are encouraged to take 76-391 Document Design and 76-487 Web Design to extend their skills in writing for print to include information design for digital media. Both courses focus on the role of the writer in these specializations and provide lab instruction in the relevant software and related computer skills.

#### Advanced Writing/Rhetoric Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-301</td>
<td>Internship</td>
<td>Var.</td>
</tr>
<tr>
<td>76-359</td>
<td>Planning and Listing Documents</td>
<td>9</td>
</tr>
<tr>
<td>76-360</td>
<td>Literary Journalism Workshop</td>
<td>9</td>
</tr>
<tr>
<td>76-372</td>
<td>Topics in Journalism</td>
<td>9</td>
</tr>
<tr>
<td>76-375</td>
<td>Magazine Writing</td>
<td>9</td>
</tr>
<tr>
<td>76-389</td>
<td>Rhetorical Grammar</td>
<td>9</td>
</tr>
<tr>
<td>76-391</td>
<td>Document Design</td>
<td>12</td>
</tr>
<tr>
<td>76-395</td>
<td>Science Writing</td>
<td>9</td>
</tr>
<tr>
<td>76-396</td>
<td>Non-Profit Advocacy: Genres, Methods, and Issues</td>
<td>9</td>
</tr>
<tr>
<td>76-397</td>
<td>Instructional Text Design</td>
<td>9</td>
</tr>
<tr>
<td>76-472</td>
<td>Advanced Journalism</td>
<td>9</td>
</tr>
<tr>
<td>76-474</td>
<td>Software Documentation</td>
<td>9</td>
</tr>
<tr>
<td>76-479</td>
<td>Marketing, Public Relations, and Corporate Communications</td>
<td>9</td>
</tr>
<tr>
<td>76-481</td>
<td>Writing for Multimedia</td>
<td>12</td>
</tr>
<tr>
<td>76-487</td>
<td>Web Design</td>
<td>9</td>
</tr>
</tbody>
</table>
English Electives (3 courses, 27 units)

PW majors complete three additional courses from the English Department’s offerings. Two of the three Electives must be courses that focus on the relationships between texts and their cultural and historical contexts. Courses in literature, cultural studies, rhetoric, and media studies that meet this requirement are advertised on a semester-by-semester basis. Please consult the list of courses published each semester by the Department for current offerings in this category. English Electives may include any course offered by the Department with the exception of 76-270 Writing for the Professions, and 76-377 Language in Design, both of which are designed for non-majors and overlap with 76-271 Introduction to Professional and Technical Writing. Additionally, Electives can include no more than one course at the 200 level. The remaining Electives must be at the 300 or 400 level. In choosing Electives, students are encouraged to consult with their advisors and to sample courses from across the Department.

Professional Writing B.A. Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must. In fact, as a Department, we strongly recommend beginning the major no later than spring of the sophomore year if at all possible. A start in the sophomore year is particularly important for students seeking to take 76-391 Document Design and 76-487 Web Design because of the sequence of prerequisites. (76-271 is a prerequisite for 76-391 and both are prerequisites for 76-487. Additionally, 76-391 and 76-487 are offered only in the fall semester.)

<table>
<thead>
<tr>
<th>Junior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-271</td>
<td>Introduction to Professional and Technical Writing</td>
<td></td>
</tr>
<tr>
<td>76-390 Style</td>
<td>76-373 Topics in Rhetoric: Argument</td>
<td></td>
</tr>
<tr>
<td>76-3xx/4xx English Elective</td>
<td>76-3xx/4xx Advanced Writing/Rhetoric Course</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-3xx/4xx English Elective</td>
<td>76-3xx/4xx Advanced Writing/Rhetoric Course</td>
<td></td>
</tr>
</tbody>
</table>

The B.S. in Technical Writing & Communication

The B.S. in Technical Writing & Communication (TWC) is one of the oldest undergraduate technical communication degrees in the country with a history that stretches back to 1958. The degree is specifically designed to prepare students for successful careers involving scientific, technical, and computer-related communication, including writing and designing for digital media.

The B.S. in Technical Writing reflects changes taking place in the technical communication fields. At one time in the not too distant past, technical writers worked primarily with print documents and within a relatively narrow range of fields that included the software industry and various organizations concerned primarily with scientific or technological objects. The recent explosion of information technologies has radically changed that situation. Today’s technical communicators are professional specialists with strong backgrounds in the technology, communication, and design skills needed to enter a broad range of information-based fields. The work that technical writers now do goes well beyond writing documents for print distribution. The expanding range of options includes positions that involve organizing, managing, communicating, and facilitating the use of both technical and non-technical information in a range of fields and media.

Some of the many things that technical communicators do include developing and designing web sites, explaining science and technology to the public, developing print and multimedia materials, developing information management systems, designing and delivering corporate training, and developing support systems for consumer products ranging from software for word processing or personal finance to complex database management systems.

The B.S. in Technical Writing recognizes the important changes taking place in communication-based careers and includes two distinctive “tracks,” one in Technical Communication (TWC) and one in Scientific and Medical Communication (SMC). Both tracks begin with a common core of foundation courses in print and on-line communication as well as a shared set of prerequisites in math, statistics, and computer programming. The two tracks differ in the set of theory/specialization courses beyond the core, with each track including a specialized set appropriate to its focus.

In both the TWC and SMC tracks, TWC students work on real projects for actual clients, learn group interaction and management skills, and develop a flexible repertoire of skills and strategies to keep up with the rapid advances in software and technology. Above all, the tracks focus on developing structures and information strategies to solve a broad range of communication and information design problems.

TWC students are able to draw on exceptional resources on and off campus to enhance their education. Most obvious are the course offerings of Carnegie Mellon’s School of Computer Science. Additional course offerings in business, organizational behavior, policy and management, psychology, history, and design are also encouraged. As a capstone experience, Senior TWC majors have the opportunity to complete a Senior Project or, upon invitation from the college, a Senior Honors Thesis in Rhetoric or Professional or Technical Writing. TWC students can also apply for Student Undergraduate Research Grants (SURG) or summer fellowships (SURF) to work on independent research projects with department faculty.

While the major appeals to students with strong professional interests, both core and elective requirements are liberal arts based. As a result, one expects from a university education and prepare students to either enter the workplace upon graduation or pursue graduate study in fields as diverse as communications, business, instructional design, information design, education, and science and healthcare writing. TWC majors also have the opportunity to apply for the Department’s accelerated MA in Professional Writing, the MAPW 4+1, which allows them to complete the degree in 2 semesters instead of the usual 3.

Various opportunities for writers to gain professional experience and accumulate material for the writing portfolios are available through campus publications, department-sponsored internships for academic credit, and writing-related employment on and off campus. TWC students have the option of doing internships for academic credit during their junior or senior year and are encouraged to pursue a series of internships throughout their 4 years and during their summer Internships provide both professional experience and exposure to the broad range of career possibilities that technical writers can pursue after graduation. Both coursework and internships also provide writing samples for students’ professional portfolios. Recent students have done internships at various off-campus sites including Rockwell Automation, Duquesne Systems, the Carnegie Mellon Robotics Institute, IBM, and the Carnegie Mellon Software Engineering Institute (SEI). Placement patterns after graduation are similarly diverse. Graduates of the Technical Writing program have been hired by organizations nationwide. Firms recruiting and hiring Technical Writing graduates include Microsoft, Intel, AT&T, Digital Equipment, IBM, Boeing, Data General, NCR Corporation, Cisco Systems, and Mellon Financial.

The Technical Communication (TC) Track

The Technical Communication track (TC) prepares students for careers in the rapidly changing areas of software and digital media. Students learn the fundamentals of visual, verbal, and on-line communication as well as the technical skills needed to design, communicate, and evaluate complex communication systems and to manage the interdisciplinary teams needed to develop them. Students become fluent in both print-based and electronic media across a variety of information genres and learn to design information for a range of specialist and non-expert audiences. The TC major can be pursued as a primary major within Dietrich College or as a secondary major for students in other Colleges with an interest in combining their specialized subject matter knowledge with strong writing and communications skills. Graduates of this track are likely to follow in the footsteps of previous Technical Writing students from Carnegie Mellon who are currently employed as web designers, information specialists, technical writers, and information consultants in a range of technology and communication-based organizations including IBM, Microsoft, Apple, and Intel, all of whom actively recruit on the Carnegie Mellon campus.

The Scientific and Medical Communication (SMC) Track

The Scientific and Medical Communication track (SMC) is designed for students who seek careers that focus on communication and information design problems in these specialized areas. It should appeal to students with interests in the health care professions, science and public policy, patient education, scientific journalism and related fields. Like the TC track, the SMC track is designed to provide both the technical and the communication skills needed to analyze and solve complex communication problems. Students learn the fundamentals of visual, verbal, and on-line communication as well as the technical skills needed to design, communicate, and evaluate complex information systems and to manage the interdisciplinary teams needed to develop them. Students become fluent in both print-based and electronic media across a variety of information genres and learn to design information for a range of specialist
and non-expert audiences. The TWC/SMC major can be pursued as a primary major within Dietrich College or as a secondary major for students in other Colleges, such as MCS, with an interest in science or medicine.

Curriculum for the TWC degree

All Technical Writing & Communication majors must satisfy the Dietrich College requirements for the B.S. degree, and a set of 3 to 4 prerequisite courses in calculus, statistics, and computer science. All prerequisites should be completed by the beginning of the fall semester, junior year. Prerequisites may double count toward Dietrich College Requirements or requirements for other majors or minors.

Mathematics Prerequisite (1 course, 10 units)

Complete one of the following:
- 21-111 Calculus I 10
- 21-112 Calculus II 10
- 21-120 Differential and Integral Calculus 10
- 21-127 Concepts of Mathematics 10

Statistics Prerequisite (1 course, 9 units)

Complete one course
- 36-201 Statistical Reasoning and Practice 9

Computer Science Prerequisites (1 - 2 courses*, 10 - 22 units)

Students in the Technical Communication track must complete two required Computer Science courses:
- 15-110 Principles of Computing 10
- 15-112 Fundamentals of Programming and Computer Science 12

Students in the Science and Medical Communication track must complete one required Computer Science course:
- 15-110 Principles of Computing 10

15-110 Principles of Computing is designed for students with little or no prior programming experience and is appropriate for students in both the SMC and TC tracks. 15-112 Fundamentals of Programming and Computer Science prepares students in the TC track for all other advanced Computer Science courses.

Beyond these prerequisites, students in both TC and SMC tracks take a common set of 5 TWC Core Requirements in writing, communication, and information design. To complement these foundations courses, TWC students take a set of 3 Theory/Specialization courses specific to either TC or SMC. In addition, students in the SMC track take a series of 3 courses in the natural sciences or engineering relevant to their areas of interest, while TC students take electives in management, technology, and social issues.

Technical Communication Track

TWC Core Requirements (5 courses, 51 units)

76-26x Survey of Forms (Nonfiction, Fiction, Poetry, or Screenwriting) 9
76-271 Introduction to Professional and Technical Writing 9
76-390 Style 9
76-391 Document Design * 12
76-487 Web Design ** 9
76-488 Web Design Lab 3

* prerequisite = 76-271 Introduction to Professional and Technical Writing
**prerequisite = 76-271 Introduction to Professional and Technical Writing + 76-391 Document Design

Theory/Specialization Courses (3 courses, 27 units)

Complete 3 Advisor-approved courses structured as follows. At least one of the three must be chosen from the “Recommended” options below. The remaining 2 courses can be from the “Recommended” or “Additional Options” lists.

Recommended Options - at least one Theory/Specialization course MUST be from this set (and all three should be strongly considered as options)
- 76-359 Planning and Testing Documents 9
- 76-397 Instructional Text Design 9
- 76-491 Rhetorical Analysis 9
- 76-494 Communication Revolutions & Technologies 9
- 76-474 Software Documentation 9
- 76-481 Writing for Multimedia * 12

or

Additional Options
- 76-301 Internship Var.
- 76-318 Communicating in the Global Marketplace 9
- 76-385 Introduction to Discourse Analysis 9

TWC / TC Track Sample Curriculum

This plan is presented as a five-semester (spring of sophomore year through senior year) plan for completing major requirements. It is to show that this program can be completed in as few as five semesters not that it should or must be. In fact, as a department, we strongly recommend beginning the major in the fall of the sophomore year if possible. The five-semester time frame is needed because of sequencing issues related to the required core courses. The plan does not include the 4 prerequisite courses, which should be completed by the junior year.

Sophomore Year

Fall
- 76-271 Introduction to Professional and Technical Writing*
- 76-390 Style

Junior Year

Fall
- 76-391 Document Design*

Senior Year

Fall
- 76-487 Web Design*
- 76-488 Web Design Lab
- 39-605-39-606 Theory/Specialization Course
Elective
Elective
Elective
Elective

* These courses must be taken in the sequence indicated. 76-271 is offered all semesters and therefore can be taken fall or spring of sophomore year. 76-271 is a prerequisite for 76-391, and 76-271 + 76-391 are the prerequisites for 76-487. 76-391 and 76-487 are offered only in the fall semesters.

Scientific & Medical Communication Track
Core Requirements for TWC (5 courses, 51 units)
Complete all 5 courses.

76-26x  Survey of Forms (Nonfiction, Fiction, Poetry, or Screenwriting)  9
76-271  Introduction to Professional and Technical Writing  9
76-390  Style  9
76-391  Document Design  12
76-487  Web Design  9
76-488  Web Design Lab  3

* prerequisite = 76-271 Introduction to Professional and Technical Writing
** prerequisite = 76-271 Introduction to Professional and Technical Writing + 76-391 Document Design

Theory/Specialization Courses (3 courses, 27 units)
Complete 3 advisor-approved courses structured as follows:

At least one of the three must be chosen from the 3 “Recommended” options below. The remaining 2 courses must be from the “Recommended” or “Additional Options” lists.

Recommended Options — at least one Theory/Specialization course MUST be from this set (and all three should be strongly considered as options):

76-395  Science Writing  9
76-476  Rhetoric of Science  9
76-494  Healthcare Communications  9

Additional Options — at least one Theory/Specialization course MUST be from this set (and all three should be strongly considered as options):

76-301  Internship  Var.
76-318  Communicating in the Global Marketplace  9
76-359  Planning and Testing Documents  9
76-372  Topics in Journalism  9
76-385  Introduction to Discourse Analysis  9
76-386  Language & Culture  9
76-387  Narrative & Argument  9
76-388  Rhetorical Grammar  9
76-396  Non-Profit Advocacy: Genres, Methods, and Issues  9
76-397  Instructional Text Design  9
76-419  Communication Revolutions & Technologies  9
76-481  Writing for Multimedia  12
76-491  Rhetorical Analysis  9
36-309  Experimental Design for Behavioral and Social Sciences  9
39-605  Engineering Design Projects  12
79-330  Medicine and Society  9
79-331  Body Politics: Women and Health in America  9
79-333  Biology and Society: Evolution Animal Experimentation and Eugenics  9
79-335  Drug Use and Drug Policy  9
80-220  Philosophy of Science  9
80-244  Environmental Ethics  9
80-245  Medical Ethics  9
88-223  Decision Analysis and Decision Support Systems  9

Other Additional Options courses may be available and will be announced on a semester-by-semester basis.

Natural Sciences & Engineering (3 courses, minimum of 27 units)
Complete 3 advisor-approved courses that contribute to the student’s chosen focus. The courses may be all in one area such as biology, or spread across areas. The basic courses in biology, chemistry, and physics are listed below. Additional options include advanced courses in any of these areas as well as basic and advanced classes in statistics, or engineering. Consult your English Department advisor on the appropriateness of specific courses for your interests. Courses in this category may double count for both the TWC/TC degree and a major or minor in another department.

03-121  Modern Biology  9
03-231  Biochemistry I  9
09-105  Introduction to Modern Chemistry I  10
09-106  Modern Chemistry II  10
09-221  Laboratory I: Introduction to Chemical Analysis  12
33-111  Physics I for Science Students  12
33-112  Physics II for Science Students  12

TWC/SMC Track Sample Curriculum

This plan is presented as a five-semester (spring of sophomore year through senior year) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as five semesters not that it should or must be. In fact, as a department, we strongly recommend beginning the major in the fall of the sophomore year if possible. The five-semester time frame is needed because of sequencing issues related to the required core courses. The plan does not include the 3 prerequisite courses, which should be completed no later than the end of the junior year.

Sophomore Year

Spring
76-271  Introduction to Professional and Technical Writing  9
76-390  Style

Fall
76-391  Document Design

Junior Year

Spring
76-26x  Survey of Forms  9
76-488  Web Design Lab

Fall
76-271  Introduction to Professional and Technical Writing*

Elective

Elective
Elective
Elective

Senior Year

Fall
76-487  Web Design*

Elective

Elective
Elective

Spring
76-3xx/4xx Theory/Specialization Course

Elective

Elective
Elective

* These courses must be taken in the sequence indicated. 76-271 is offered all semesters and therefore can be taken fall or spring of sophomore year. 76-271 is a prerequisite for 76-391, and 76-271 + 76-391 are the prerequisites for 76-487. 76-391 and 76-487 are offered only in the fall semesters.

Completing an Additional Major in English

Students with interests that include more than one of the department’s majors have the option of completing an additional major within the department. Students may combine any of the B.A. degrees or combine the B.S. in Technical Writing and Communication with either the B.A. in English or the B.A. in Creative Writing. Students may not combine the Professional Writing and the Technical Writing & Communication majors because so many of the courses overlap.

Students majoring in two or more English Department degrees must fulfill the Core Requirements for the Major for both programs. The Survey of Forms course core requirement, common to all 4 majors, needs to be taken only once but can count toward both majors. Similarly, the English Electives need to be taken only once and can count toward both majors with the understanding that a student must complete the number of English Electives required by the program with the higher number of Electives. For example, a student combining the B.A. in English with the Creative Writing major would take the 4 English Electives required for Creative Writing.

Because the Survey of Forms course and the English Electives are allowed to double count toward both majors, students who are already majoring in one of the English degrees can generally add a second major within the department by completing 6 to 8 additional courses. For example, a student who has fulfilled all 11 requirements for the BA in English can complete the additional major in Creative Writing by adding the 6 courses of the Creative Writing Core beyond the first Survey of Forms requirement: one additional Survey of Forms course, one Reading in Forms course, and 4 Writing Workshops. Because sequencing of courses can become an issue when doing multiple majors, students are strongly advised to consult closely with their English Department advisors about the sequence of their courses.

Completing a Secondary Major in English

Students in other departments who wish to complete a secondary major in the English Department should contact the Academic Coordinator in the English Department Office to file a secondary major application form and be assigned to an English Department advisor. Secondary majors in the four English degrees are required to complete all requirements for the chosen
major. Additionally, courses taken to fulfill requirements within the primary major may not double count for requirements within the chosen English Department major. The only exceptions to this rule are the TC electives for the TWC/TC degree and the Natural Science and Engineering requirements for the TWC/SCM degree. In planning schedules for a secondary major, it is critically important that students consult with both departments in which they are majoring to be sure that all requirements for graduation can be met.

**Minor in English**

The English Department also offers minors in Creative Writing, English Studies, Professional Writing, and Technical Writing. The minors require a minimum of five courses (45 units), plus completion of (or credit for) Interpretation and Argument (76-101) or an equivalent requirement. The minors in English are available to all undergraduate students except English majors, who may not both major and minor in English.

Courses taken to fulfill requirements in other major or minor programs may not be applied to English minor requirements (and vice versa).

Courses that meet the various requirements are advertised on a semester-by-semester basis. Full descriptions are available each semester from the English Department main office. We also publish a document titled “What Counts for What Minors,” which indicates which courses offered in a given term fulfill specific requirements in each of the minor concentrations.

**English Studies Minor**

Complete 6 courses, including Interpretation and Argument (76-101) as a prerequisite.

76-101 Interpretation and Argument (or credit for equivalent course) 9
76-294 Interpretive Practices (prerequisite for 300- and 400-level courses) 9
76-3xx Two 300-level courses in Literature, Cultural Studies, or Rhetoric 18
76-3xx/4xx One additional 300-level course or 400-level seminar in Literature, Cultural Studies, or Rhetoric 9
76-xxx 200-level or above English Elective ** 9

* Note that at least some 400-level seminars have Research in English (76-394) as a pre- or co-requisite. Students planning to take a 400-level seminar to fulfill this requirement should plan to take Research in English (76-394) as one of their 300-level courses.

** The English Elective may be any course offered by the English Department.

**Creative Writing Minor**

Complete 6 courses, including Interpretation and Argument (76-101) as a prerequisite.

76-101 Interpretation and Argument (or credit for equivalent course) 9
76-26x Survey of Forms 9
76-3xx/4xx Two Fiction, Poetry, or Screenwriting Workshop Classes 18
76-3xx One Reading in Forms Course 9
76-xxx One 200-level or above English Elective ** 9

* A student must receive a grade of A or B in the Survey of Forms class in order to be eligible to enroll in a workshop of that genre. A student who receives a grade of C in a Survey of Forms course may enroll in a related workshop only with the permission of his or her workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

** The English Elective may be any course offered by the English Department.

**Professional Writing Minor**

Complete 6 courses, including Interpretation and Argument (76-101) as a prerequisite.

76-101 Interpretation and Argument (or credit for equivalent course) 9
76-270 Writing for the Professions or 76-271 Introduction to Professional and Technical Writing 9
76-3xx/4xx Two 300- or 400-level Writing courses * 18
76-3xx/4xx One Rhetoric/Language Studies course * 9
76-xxx One 200-level or above English Elective ** 9

* 76-270 Writing for the Professions or 76-271 Introduction to Professional and Technical Writing is generally the prerequisite for these 300- and 400-level courses. Options include but are not limited to 76-318 Communicating in the Global Marketplace, 76-359 Planning and Testing Documents, 76-372 Topics in Journalism, 76-375 Magazine Writing, 76-389 Rhetorical Grammar, 76-390 Style, 76-391 Document Design, 76-395 Science Writing, 76-396 Non-Profit Advocacy: Genres, Methods, and Issues 76-472 Advanced Journalism, 76-479 Marketing, Public Relations, and Corporate Communications, 76-481 Writing for Multimedia, 76-487 Web Design, 76-491 Rhetorical Analysis, 76-494 Healthcare Communications, and other options advertised on a semester-by-semester basis.

** The English Elective may be any course offered by the English Department.

**Technical Writing Minor**

Complete 6 courses, including Interpretation and Argument (76-101) as a prerequisite.

76-3xx/4xx Two 300- or 400-level courses* from these options:

76-101 Interpretation and Argument 9
76-271 Introduction to Professional and Technical Writing 9
76-xxx/76-4xx Two 300- or 400-level courses chosen from the Writing Course Options listed below 9
76-xxx/4xx One Rhetoric/Language Studies course 9

* Options include but are not limited to 76-318 Communicating in the Global Marketplace, 76-359 Planning and Testing Documents, 76-389 Rhetorical Grammar 76-372 Topics in Journalism, 76-391 Document Design, 76-395 Science Writing, 76-396 Non-Profit Advocacy: Genres, Methods, and Issues 76-472 Advanced Journalism, 76-479 Marketing, Public Relations, and Corporate Communications, 76-481 Writing for Multimedia, 76-487 Web Design, 76-488 Web Design Lab, 76-491 Rhetorical Analysis, 76-494 Healthcare Communications, and other options advertised on a semester-by-semester basis. 76-271 Introduction to Professional and Technical Writing is generally the prerequisite for these 300- and 400-level courses. Additionally, 76-391 Document Design is a prerequisite for both 76-481 Writing for Multimedia and 76-487 Web Design.

** The English Elective may be any course offered by the English Department.

**Senior Honors Thesis**

Seniors in all majors in the English Department who meet the necessary requirements are invited by the College of Humanities and Social Sciences (Dietrich College) to propose and complete a Senior Honors Thesis during their final year of study. The thesis may focus on research and/or original production in any of the areas offered as a major within the Department. To qualify for the Dietrich College Honors Program, students must have a cumulative Quality Point Average of at least 3.50 in their major and 3.25 overall at the end of their junior year and be invited by Dietrich College to participate. Students then choose a thesis advisor within the Department and propose and get approval from Dietrich College for a Senior Honors Thesis. The Honors Thesis is completed over the two semesters of the senior year (9 units each semester) under the direction of the chosen advisor. By successfully completing the thesis, students earn 18 units of credit and qualify for graduation with "College Honors."

Creative Writing majors participating in the Senior Honors Thesis program may petition to have one semester of their thesis work count as one of their Workshop course requirements. Students interested in this option should contact the Director of Undergraduate Studies.

**Internship Program**

Qualified students in all four of the Department’s degree programs have the option of doing one or more professional internships for academic credit during their junior or senior years. These opportunities help students explore possible writing-related careers as well as gain workplace experience. Each internship is arranged, approved, and overseen by the Department’s Internship Coordinator. Particular attention is given to matching students to internship sites of specific interest to them. Students have interned in a wide variety of communications-related positions including placements at local radio, television, and print publications; museums, theaters, and cultural organizations; non-profit and public service organizations; public relations, advertising, and marketing firms; software and technology companies; new media organizations; and hospitals and healthcare communication organizations.

To be eligible for an internship, students must have a Quality Point Average of 3.0 or better and credit for at least one writing course (including Survey of Forms) beyond Interpretation and Argument (76-101). Internships generally carry 3-12 units of credit. A 9-unit internship is the standard and requires a minimum of 120-140 hours (8-10 hours per week over a 15-week term) of work at the internship site during the term. In addition, interns complete a reflective journal and a series of short research and writing assignments relevant to the specific internship. Students doing an internship for credit must be registered for the internship during the term (including summer) when they are working at the internship site. Majors in
the Department may count one 9-12 unit internship for one of their degree requirements, generally an English elective.

The Accelerated MA in Professional Writing: MAPW 4+1

The MAPW 4+1 is a special program under which Carnegie Mellon students (usually majors or minors in the English department or BHA or BHS students with relevant coursework) can qualify to complete the MA in Professional Writing in 2 semesters instead of the usual 3. Students apply for admissions during their junior or senior year and, following admission and evaluation of their transcripts, may receive credit for up to four courses, or one full semester of work toward the MA requirements. The degree has a professional focus, combines intensive work in both writing and visual design, and prepares students for a range of communications careers. The coursework and career options most commonly pursued by students in the degree include:

- Writing for New Media, including web design and information design
- Writing for Print Media, including Journalism
- Editing & Publishing
- Technical writing, including instructional design
- Science, Technology, and Healthcare Writing
- Public & Media Relations / Corporate Communications / Nonprofit Communication

4+1 students are also eligible to apply for the department’s new masters degree in Investigative Journalism, which builds on the MAPW and involves an additional year of study including a fall semester of study abroad in Scotland followed by a final spring semester in which if students complete an investigative project and related thesis under the joint supervision of faculty in both Scotland and Pittsburgh.

Students interested in applying to the 4+1 program should consult the Director of the MAPW program early in their junior year for further details and advice on shaping undergraduate coursework to qualify for this option. Detailed information on the program and relevant financial aid is available at http://english.cmu.edu/ under the tab for the MAPW.

Faculty

MARIAN AGUIAR, Associate Professor of English and Literary and Cultural Studies – Ph.D., University of Massachusetts; Carnegie Mellon, 2002–.

AMAL AL-MALKI, Assistant Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., University of London; Carnegie Mellon, 2003–.

DIANA AWAD SCROCCO, Assistant Teaching Professor – Ph.D., Kent State University; Carnegie Mellon, 2012–.

JANE BERNSTEIN, Professor of English and Creative Writing – M.F.A., Columbia University; Carnegie Mellon, 1991–.

GERALD P. COSTANZO, Professor of English and Creative Writing – M.A., M.A.T., Johns Hopkins University; Carnegie Mellon, 1970–.

JAMES DANIELS, Thomas S. Baker Professor of English and Creative Writing – M.F.A., Bowling Green State University; Carnegie Mellon, 1981–.

SHARON DILWORTH, Associate Professor of English and Creative Writing – M.F.A., University of Michigan; Carnegie Mellon, 1989–.

LINDA FLOWER, Professor of English and Rhetoric – Ph.D., Rutgers University; Carnegie Mellon, 1980–.

LOIS FOWLER, Professor Emeritus of English.

SUSAN HAGAN, Assistant Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004–.

YONA HARVEY, Assistant Teaching Professor of English and Creative Writing – M.F.A., The Ohio State University; Carnegie Mellon, 2007–.

TERRANCE HAYES, Professor of English and Creative Writing – M.F.A., University of Pittsburgh; Carnegie Mellon, 2001–.

PAUL HOPPER, Paul Mellon Distinguished Professor Emeritus of the Humanities, Rhetoric and Linguistics – Ph.D., University of Texas; Carnegie Mellon, 1990–.

LUDMILA HYMAN, Assistant Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

SUGURU ISHIZAKI, Associate Professor of Rhetoric and Visual Design – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2005–.

BARBARA JOHNSTONE, Professor of Rhetoric and Linguistics – Ph.D., University of Michigan; Carnegie Mellon, 1997–.

ANDREAS KARATSOLIS, Assistant Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., Rensselaer Polytechnic Institute; Carnegie Mellon, 2005–.

DAVID S. KAUFER, Professor of English and Rhetoric – Ph.D., University of Wisconsin; Carnegie Mellon, 1980–.

ALAN KENNEDY, Professor of English and Literary and Cultural Studies – Ph.D., University of Edinburgh; Carnegie Mellon, 1989–.

JON KLANCHER, Associate Professor of English and Literary and Cultural Studies – Ph.D., University of California at Los Angeles; Carnegie Mellon, 1999–.

PEGGY A. KNAPP, Professor of English and Literary and Cultural Studies – Ph.D., University of Pittsburgh; Carnegie Mellon, 1970–.

HILARY MASTERS, Professor of English and Creative Writing – A.B., Brown University; Carnegie Mellon, 1983–.

JANE MCCAFFERTY, Associate Professor of English and Creative Writing – M.F.A., University of Pittsburgh; Carnegie Mellon, 1997–.

CHRISTINE NEUWIRTH, Professor of English and Human Computer Interaction; Head of the English Department – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–.

KATHLEEN NEWMAN, Associate Professor of English and Literary and Cultural Studies – Ph.D., Yale University; Carnegie Mellon, 2011–.

JOHN J. ODDO, Assistant Professor of English and Rhetoric – Ph.D., Kent State University; Carnegie Mellon, 2011–.

SILVIA PESSOA, Assistant Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

RICHARD PURCELL, Assistant Professor of English and Literary and Cultural Studies – Ph.D., University of Pittsburgh; Carnegie Mellon, 2008–.

DUDLEY REYNOLDS, Teaching Professor, Liberal & Social Sciences, Carnegie Mellon University-Qatar – Ph.D., Indiana University, Bloomington; Carnegie Mellon, 1996–.

ANDREA RITIVOI, Associate Professor of English and Rhetoric – Ph.D., University of Minnesota; Carnegie Mellon, 2001–.

KAREN SCHNAKENBERG, Teaching Professor Emeritus of Rhetoric and Professional Writing – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995–.

DAVID R. SHUMWAY, Professor of English and Literary and Cultural Studies – Ph.D., Indiana University; Carnegie Mellon, 1985–.

ERWIN R. STEINBERG, Professor Emeritus of English and Rhetoric – Ph.D., New York University; Carnegie Mellon, 1946–.

KRISTINA STRAUB, Professor of English and Literary and Cultural Studies; Associate Head of the English Department – Ph.D., Emory University; Carnegie Mellon, 1987–.

CHRISTOPHER WARNER, Assistant Professor of English and Literary and Cultural Studies – Ph.D., University of Oxford; Carnegie Mellon, 2010–.

NECIA WERNER, Assistant Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2011–.

DANIELLE WETZEL, Associate Teaching Professor of English and Rhetoric; Director of First-Year English – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006–.

JEFFREY WILLIAMS, Professor of English and Literary and Cultural Studies – Ph.D., Stony Brook University; Carnegie Mellon, 2004–.

JOANNA WOLFE, Teaching Professor – Ph.D., The University of Texas at Austin; Carnegie Mellon, 2001–.

JAMES WYNN, Associate Professor of English and Rhetoric – Ph.D., University of Maryland; Carnegie Mellon, 2006–.

RICHARD YOUNG, Professor Emeritus of English.
### Department of History

Caroline Acker, Department Head  
Department Office: Baker Hall 240  
http://www.hss.cmu.edu/departments/history

Undergraduate programs in History focus on new ways to understand the past and new ways to use what we know. Department faculty offer three different degree programs: the B.A. in History, the B.A. in Global Studies, and the interdepartmental B.A. or B.S. in Ethics, History, and Public Policy (described both here and in the catalog section on Interdepartmental Majors). All three focus on connections between past and present and on how historical knowledge facilitates understanding of social, cultural, and policy change. Our degree programs emphasize empirical methods and conceptual analysis, as well as specific research skills relevant to many types of jobs and further professional training. The Department’s mission also includes courses introducing students to various societal settings and diverse types of controversial public issues, thus contributing actively to both liberal education and professional development.

Each of the three degree programs combines a structured sequence of courses, training in research methods, theoretical concepts, and analytical writing skills, plus a considerable array of electives. Each program stems from the teaching and research strengths of a department that is internationally known for its innovative historical and anthropological approaches to the study of social, cultural, and policy change.

Our degree programs prepare students for many career options. There is, of course, a historical profession, composed largely of research scholars and teachers who have completed a Ph.D., and graduates of the CMU History Department have gone on to earn doctorates at Harvard, Northwestern, and other major universities. More often, graduates of our department pursue post-undergraduate professional school, such as law, business administration, public policy, urban planning, librarianship, journalism, the ministry, or social work. Most schools in these fields prefer students who have acquired a strong liberal education and broad perspectives on human problems, rather than students with narrowly specialized training or skills.

History is also excellent preparation for careers that may begin immediately upon graduation, including business; indeed, most graduates of history departments, at Carnegie Mellon and elsewhere, take jobs in business and management. Having been trained to analyze subtle and complex issues, to develop breadth of understanding, to dig out information and make sense of it, and to present their findings effectively, our graduates do extremely well in many types of organizations, both public and private. The U.S. Foreign Service is another traditional avenue for graduates from history departments, especially in combination with foreign language skills. Many other government and non-profit agencies actively recruit history and other liberal arts graduates. Because history courses emphasize research and writing skills plus analysis of social and policy trends, they offer good preparation for journalism and other writing careers.

All three of our degree programs combine easily and well with complementary majors in areas such as Business, Economics, Professional Writing, Statistics, Philosophy, Political Science, or Modern Languages.

An option to pursue a general minor in the Department of History is detailed below; several other minors, described throughout the Undergraduate Catalog, can be linked with any degree program in History to provide additional depth. These include Dietrich College of Humanities and Social Sciences minors in such fields as African and African American Studies; Gender Studies; Film and Media Studies; Religious Studies; Environmental Studies; Policy and Management; European Studies; Russian Studies, and Science, Technology and Society. Examples in other colleges include minors offered in the arts, engineering, science, mathematics, business, and computer science. History faculty are also integral participants in four interdepartmental majors described elsewhere in this catalog: Ethics, History, and Public Policy; European Studies; Russian Studies; and International Relations and Politics.

The Department of History supports two research centers to coordinate sponsored research by faculty and graduate students. These include the Center for African American Urban Studies and the Economy (CAUSE) (Joe W. Trotter, Director), and the Center for the Arts and Society (Paul Eiss, Director).

### Internship Program

The History Department offers internships (or supervised off-campus work experiences) designed for qualified junior and senior majors.

### Undergraduate Research Fellow

Highly qualified history majors with prior research experience may apply to serve in their senior year as research fellows. Permission of Department Head is required.

### Senior Thesis

Seniors may write a thesis with permission of the Director of Undergraduate Studies and a designated faculty member who will supervise its completion. By completing the thesis, the student earns 18 units of credit.

### Senior Honors Thesis

The H&SS college-level Honors Program may be undertaken by students completing the B.A. in History, the B.A. in Global Studies, or the interdepartmental B.A./B.S. in Ethics, History, and Public Policy. Eligibility requirements are set by the college, and additional departmental requirements may apply depending on which of the three majors a student is completing; see the relevant academic advisor and/or the Director of Undergraduate Studies for details.

### Study Abroad Program

In addition to Study Abroad Programs organized by the Office of International Education, the History Department, in conjunction with the Modern Languages Department, conducts short-term cultural studies abroad during Spring break. Study abroad not only helps History majors better understand the past, but also the relationship between cultural heritage and modern political processes in a host country. To make study abroad successful and to find how study abroad fits into requirements, History majors prepare study abroad proposals through close consultation with their History advisor.

### The B.A. in History

Academic Advisor: Dr. Naum Kats, Baker Hall 240, 412/268-2880; kats@andrew.cmu.edu.

This program emphasizes broad-based, cumulative knowledge and interpretive skills in the study of the past. Offerings at the 200- and 300-level are designed to allow maximum flexibility in meeting requirements and maximum choice in focusing on particular themes, places, or eras. Upper-level courses aim to give students majoring in History more time together in smaller classes and more experience working with primary and secondary sources. The senior capstone seminar, “Advanced Studies in History,” provides training and experience in conducting original research and in interpretive, analytical writing – skills that prepare graduates for professional careers as well as for graduate or law school.

### Curriculum

Students graduating with a primary major in History receive a Bachelor of Arts degree; this program may also be taken as an additional (e.g., second) major. Requirements for the B.A. in History are Global Histories (79-104) plus an additional 87 units that include survey courses in the United States and other parts of the world, four courses that center entirely or in part on research projects, and two courses that cover time periods before the 20th century. For students whose primary major is the B.A. in History, no course may be double counted.

#### I. Required General Education Course (9 units)

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>79-104</td>
<td>Global Histories</td>
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</tbody>
</table>

#### II. Required Survey Courses (27 units)

Choose one 9-unit course from each category below.

**Category 1: United States (9 units)**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>79-240</td>
<td>The Development of American Culture</td>
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</tbody>
</table>

**Category 2: Regional (9 units)**

- **Europe** (Europe, East Asia, South Asia, Africa, Latin America, Caribbean, Middle East)
- **North America** (North America, Latin America, Caribbean, Middle East)
- **South America** (South America, Latin America, Caribbean, Middle East)
- **Africa** (Africa, Latin America, Caribbean, Middle East)
- **Asia** (Asia, Latin America, Caribbean, Middle East)
- **Middle East** (Middle East, Latin America, Caribbean, Middle East)

Choose one (9 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>79-202</td>
<td>Flash and Spirit: Early Modern Europe, 1400-1750</td>
</tr>
<tr>
<td>79-205</td>
<td>20th Century Europe</td>
</tr>
<tr>
<td>79-207</td>
<td>Development of European Culture</td>
</tr>
<tr>
<td>79-208</td>
<td>Europe’s Two Revolutions: Dynamics of Change in the 19th Century</td>
</tr>
<tr>
<td>79-212</td>
<td>China and its Neighbors: Minorities, Conquerors and Tribute Bearers</td>
</tr>
<tr>
<td>79-213</td>
<td>Nationalities and the New States of the Former USSR</td>
</tr>
</tbody>
</table>

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**Notes:**
- The Honors Program in History may apply depending on which of the three majors a student is completing; see the relevant academic advisor and/or the Director of Undergraduate Studies for details.
- The study abroad requirements may apply depending on which of the three majors a student is completing; see the relevant academic advisor and/or the Director of Undergraduate Studies for details.
Courses with a research component
(two courses are required, for a total of 18 units)

79-361 Protest, Propaganda and the Public Sphere, 1500-1800
9
79-362 Law and Disorder in Early Modern Europe, 1400-1800
9
79-368 Poverty, Charity, and Welfare
9
79-371 African American Urban History
9
79-377 Food, Culture, and Power: A History of Eating
9
79-385 The Making of the African Diaspora
9
79-396 Music and Society in 19th and 20th Century Europe and the U.S.
9

V. Senior Capstone Research Seminar (12 units)
79-420 Advanced Studies in History
12

B.A. in History — Sample Curriculum
Pre-requisite: 79-104 Global Histories

<table>
<thead>
<tr>
<th>Junior Fall</th>
<th>Spring Regional Survey</th>
<th>Senior Fall Non-U.S. Survey</th>
<th>Spring Distribution Requirement (Pre-1900) Distribution Requirement (Research)</th>
</tr>
</thead>
</table>
rigorous yet flexible Global Studies curriculum combines anthropology, history, literary and cultural studies, and advanced language training in order to help students make sense of complex interactions among global processes, regional and local cultures, and societal structures. Global Studies majors develop a broad understanding of their prospects and responsibilities as citizens of the world confronting challenging contemporary problems.

There are two required courses for the major: Introduction to Global Studies (79-275) and Advanced Seminar in Global Studies (79-400). Majors also have to select from several courses focused on theory, transnational histories, and regional/national histories and cultures. Demonstrating intermediate to advanced level proficiency in a language other than English is a crucial component of the major in Global Studies.

In addition to coursework at Carnegie Mellon, Global Studies majors are encouraged to incorporate a semester of study abroad into their course of study in order to immerse themselves in a society different from their own with unfamiliar cultural practices, language, and history. Majors should consult frequently with the program’s advisor and with participating faculty who will help students to craft a coherent course of study on specific regions and/or topics that may lead to the development of independent research projects. Program faculty and the academic advisor will also work with students to connect their academic interests and their participation in student organizations and/or organizations based in Pittsburgh with transnational reach.

Curriculum

Students graduating with a primary major in Global Studies receive a Bachelor of Arts degree. Global Studies may also be taken as an additional (e.g., second) major. Required courses include 79-104 plus 9 additional units (including 79-275 and 79-400) and proficiency in a modern language other than English. Students may double count a maximum of two courses taken for the B.A. in Global Studies that are also being used to fulfill the requirements of other majors and programs. Students should consult with the Global Studies advisor (see above) about new courses and study abroad courses that may be approved for students pursuing the B.A. in Global Studies.

I. Required General Education Course (9 units)

79-104 Global Histories 9

II. Global Studies Introductory Course (9 units)

Students must earn a final grade of "C" or better for the course to count toward the major.

79-275 Introduction to Global Studies 9

III. Language Requirement

Demonstrating intermediate to advanced level proficiency in a language other than English is a crucial component of the B.A. in Global Studies. Normally this requirement can be satisfied by successfully completing a course conducted in the second language at the 300 level or above for French, German, Italian, or Spanish, or the fourth semester (Intermediate II) level or above for Arabic, Chinese, Japanese, or Russian. Comparable proficiency for other languages can be considered. Additional advanced cultural, historical, and literary study in the second language is strongly recommended. Courses in a language other than English may also be counted as Global Studies distribution courses or Global Studies electives as appropriate, and students may receive credit for "Language Across the University" courses and appropriate internship and service learning options.

IV. Theoretical and Topical Core Courses (18 units)

To gain a solid foundation in the theories and analytical topics underpinning the B.A. in Global Studies, students select 18 units (typically two classes) from the core courses listed below. Students must earn a final grade of "C" or better in these courses to fulfill the theoretical and topical core course requirement.

79-276 The Global & Local: Theory, Practice & History in Anthropology of Globalization 9
79-277 Globalizing States: Culture, Power, and Politics 9
79-278 Rights to Representation: Indigenous Peoples and their Media 9
79-280 Experiencing Globalization 9
79-297 Dilemmas and Controversies in Anthropology 9
79-313 Objects of Value 9
79-317 Art, Anthropology and Empire 9
79-318 Sustainable Social Change: History and Practice 9
79-316 Nationality and Ethnicity 9
79-377 Food, Culture, and Power: A History of Eating 9
79-380 Ethnographic Methods 9
79-381 Energy, Environment, Globalization in the Americas 9

V. Transnational, Global, and Regional Courses (27 units)

To gain insight into how complex transnational and global processes shape and are affected by local, national, and regional dynamics, students will select 27 units (typically three courses) from one or both of the subcategories below.

Transnational and Global Courses

76-318 Communicating in the Global Marketplace 9
76-322 Global Masculas: South Asians in Diaspora 9
76-327 Special Topics in Literary and Cultural Studies 9
76-337 Global Literature 9
76-353 Global Studies 9
76-440 Postcolonial Theory 9
76-212 China and Its Neighbors: Minorities, Conquerors and Tribute Bearers 9
76-244 Mayan America 9
76-231 The United States and the Middle East since 1945 9
76-237 Comparative Slavery 9
76-251 India-America: Democracy, Diversity, Development 9
76-254 The Jewish Diaspora in Latin America 9
76-282 Eurohistory 9
76-286 Gandhi and King: Nonviolent Leadership in a Globalized World 9
76-288 Banana, Baseball, and Borders: A History of Latin America - US Relations 9
76-292 China Inside Out: Going Global, 19th to 21st Centuries 9
76-295 Race Relations in the Atlantic World 9
76-298/80-447 Special Topics: Global Justice 9
76-299 Trafficking Persons: Children in a Global Context 9
76-355 World Citizenship 9
76-383 Epidemic Disease and Public Health 9
76-385 The Making of the African Diaspora 9
80-136 Social Structure, Public Policy & Ethics 9
80-244 Environmental Ethics 9
80-348 Health Development and Human Rights 9
82-304 The Francophone World 9
82-345 Introduction to Hispanic Literary and Cultural Studies 9
88-326 Theories of International Relations 9
88-359 Globalization 9

Regional Courses

Africa:
76-225 West African History in Film 9
76-226 Introduction to African History: Earliest Times to 1780 9
76-227 Introduction to African History: 1780-1994 9
76-236 Introduction to African Studies 9
76-290 States/Stateless Societies and Nationalism in West Africa 9
76-291 Globalization in East African History 9
76-386 Entrepreneurs in Africa, Past, Present and Future 9
82-404 Francophone Realities: Africa 9
88-370 African Politics 9

Eastern and Southern Asia and the Pacific:
76-354 South Asian Literature 9
76-358 Claiming the Pacific: Pacific Islander Struggles for Survival 9
82-431 China and the West 9
88-411 The Rise of the Asian Economies 9

Europe:
76-202 Flesh and Spirit: Early Modern Europe, 1400-1750 9
76-205 20th Century Europe 9
76-207 Development of European Culture 9
76-213 Nationalities and the New States of the Former USSR 9
76-323 Family Gender and Sexuality in European History, 500-1800 9
82-320 Contemporary Society in Germany, Austria and Switzerland 9
82-323 Germany, Austria and Switzerland in the 20th Century 9
82-415 Topics in French and Francophone Studies 9
82-416 Topics in French and Francophone Studies 9
82-441 Studies in Peripheral Literature and Culture 9
82-491 Literature, Politics and Film in Russia & East Europe Today 9

The Middle East:
76-229 Origins of the Arab-Israeli Conflict, 1880-1948 9
76-230 Arab-Israeli Conflict and Peace Process since 1948 9
76-307 Religion and Politics in the Middle East 9
76-398 Documenting the 1987 Arab-Israeli War 9
76-399 US-Arab Encounters 9

The Americas:
76-220 Caribbean: Cultures and Histories 9
76-221 Development and Democracy in Latin America 9
76-222 Between Revolutions: The Development of Modern Latin America 9
76-235 Caribbean Cultures 9
82-343 Latin America: Language and Culture 9
82-445 U.S. Latino Literature 9
82-451 Studies in Latin American Literature and Culture 9
### VI. Elective Courses (27 units)

Students are required to take an additional 27 units (typically 3 courses) of electives, selected from one or both of the subcategories below. Category IV and V courses listed above that are not used to fulfill those requirements may be counted as electives in addition to the courses listed below.

Those students who wish to pursue an optional Global Studies Senior Thesis (9 units) as one of their electives may do so by arrangement with Global Studies faculty; the thesis will often involve work in a language other than English. This option is not to be confused with the two-semester Dietrich College Senior Honors Thesis, for graduating with college-level honors.

#### Thematic Courses

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-342</td>
<td>Managing Across Cultures</td>
<td>9</td>
</tr>
<tr>
<td>70-365</td>
<td>International Trade and International Law</td>
<td>9</td>
</tr>
<tr>
<td>70-238</td>
<td>Media and Film Studies</td>
<td>9</td>
</tr>
<tr>
<td>70-239</td>
<td>Introduction to Film Studies</td>
<td>9</td>
</tr>
<tr>
<td>70-241</td>
<td>Introduction to Gender Studies</td>
<td>9</td>
</tr>
<tr>
<td>70-378</td>
<td>Literacy: Educational Theory and Community Practice</td>
<td>9</td>
</tr>
<tr>
<td>70-386</td>
<td>Language &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>70-450</td>
<td>History of Critical Ideas: Problems of Reading, Interpretation &amp; Spectatorship</td>
<td>9</td>
</tr>
<tr>
<td>79-281</td>
<td>Introduction to Religion</td>
<td>9</td>
</tr>
<tr>
<td>79-296</td>
<td>Perspectives on Social Protest</td>
<td>9</td>
</tr>
<tr>
<td>79-311</td>
<td>Introduction to Anthropology</td>
<td>9</td>
</tr>
<tr>
<td>79-314</td>
<td>The Politics and Culture of Memory</td>
<td>9</td>
</tr>
<tr>
<td>79-319</td>
<td>Bohemians and Other Cultural Rebels</td>
<td>9</td>
</tr>
<tr>
<td>79-320</td>
<td>Women, Politics, and Protest</td>
<td>9</td>
</tr>
<tr>
<td>79-325</td>
<td>Art and Religion</td>
<td>9</td>
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<tr>
<td>79-330</td>
<td>Medicine and Society</td>
<td>9</td>
</tr>
<tr>
<td>79-331</td>
<td>Body Politics: Women and Health in America</td>
<td>9</td>
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<tr>
<td>79-332</td>
<td>Medical Anthropology</td>
<td>9</td>
</tr>
<tr>
<td>79-333</td>
<td>Biology and Society: Evolution Animal Experimentation and Eugenics</td>
<td>9</td>
</tr>
<tr>
<td>79-334</td>
<td>Law, Ethics, and the Life Sciences</td>
<td>9</td>
</tr>
<tr>
<td>79-342</td>
<td>Introduction to Science and Technology Studies</td>
<td>9</td>
</tr>
<tr>
<td>79-349</td>
<td>The Holocaust in Historical Perspective</td>
<td>9</td>
</tr>
<tr>
<td>79-368</td>
<td>Poverty, Charity, and Welfare</td>
<td>9</td>
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<tr>
<td>79-382</td>
<td>History of Biomedical Research</td>
<td>9</td>
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<tr>
<td>79-506</td>
<td>Global Studies Internship</td>
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<tr>
<td>80-247</td>
<td>Ethics and Global Economics</td>
<td>9</td>
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<tr>
<td>80-335</td>
<td>Deliberative Democracy: Theory and Practice</td>
<td>9</td>
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<td>80-344</td>
<td>Management, Environment, and Ethics</td>
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<tr>
<td>82-215</td>
<td>Introduction Modern Arabic Literature and Culture</td>
<td>Var.</td>
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<tr>
<td>82-311</td>
<td>Arabic Language and Culture I</td>
<td>9</td>
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<tr>
<td>82-312</td>
<td>Arabic Language and Culture II</td>
<td>9</td>
</tr>
<tr>
<td>82-358</td>
<td>Literacies Across Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-384</td>
<td>Language and Culture: Language in its Social Context</td>
<td>9</td>
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<tr>
<td>82-506</td>
<td>Hispanic Studies Internship</td>
<td>9</td>
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<tr>
<td>82-541</td>
<td>Special Topics: Hispanic Studies</td>
<td>9</td>
</tr>
<tr>
<td>88-205</td>
<td>Comparative Politics</td>
<td>9</td>
</tr>
<tr>
<td>88-314</td>
<td>Politics through Film</td>
<td>9</td>
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<tr>
<td>88-357</td>
<td>Comparative Foreign Policy: China, Russia, and the US</td>
<td>9</td>
</tr>
<tr>
<td>88-362</td>
<td>Diplomacy and Statecraft</td>
<td>9</td>
</tr>
<tr>
<td>88-368</td>
<td>Conflict, Human Rights and Development</td>
<td>9</td>
</tr>
<tr>
<td>88-378</td>
<td>International Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-384</td>
<td>Conflict and Conflict Resolution in International Relations</td>
<td>9</td>
</tr>
<tr>
<td>88-408</td>
<td>Attitudes the Media and Conflict in International Relations</td>
<td>9</td>
</tr>
<tr>
<td>88-412</td>
<td>Economics of Global Warming</td>
<td>9</td>
</tr>
</tbody>
</table>

### VII. Senior Capstone Course (12 units)

Students must earn a final grade of "C" or better for the course to count toward the major.

**Students are not required to complete a college honors thesis. However, many Global Studies majors choose to apply for the senior honors thesis.**

### B. A. in Global Studies — Sample Curricula

These sample curricula represent a plan for completing the requirements for the B.A. in Global Studies. Global Studies students are encouraged to spend a semester abroad and the plan below demonstrates that study abroad fits well into the curriculum. As with most majors in the Dietrich College, the Global Studies major can be completed in as few as two years of undergraduate study, not that it must be. Students may declare the B.A. in Global Studies and take appropriate courses as early as the second semester of the freshman year and as late as the junior year, and should consult frequently with the Global Studies advisor (see above) about their course of study in Pittsburgh and possibly abroad.

#### Freshman

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>79-104 Global Histories</td>
<td>9</td>
</tr>
<tr>
<td>Spring</td>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>Freshman Seminar</td>
<td>Language Course or Gen Ed</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Sophomore

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>79-400 Advanced Seminar in Global Studies</td>
<td>12</td>
</tr>
<tr>
<td>Spring</td>
<td>82-342 Spain: Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>Senior</td>
<td>79-265 Russian History: From the First to the Last Tsar</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>79-266 Russian History: From Communism to Capitalism</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Junior

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>79-249 Introductory Japanese Language Culture</td>
<td>9</td>
</tr>
<tr>
<td>Spring</td>
<td>82-273 Introduction to Japanese Culture and Language</td>
<td>9</td>
</tr>
<tr>
<td>Elective</td>
<td>Language Course or Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Senior

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>82-345 Topics in Japanese Studies</td>
<td>9</td>
</tr>
<tr>
<td>Spring</td>
<td>82-474 Topics of Japanese Studies</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>79-255 Irish History</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>79-359 Sustainable Innovations: Ideas, Policies &amp; Technologies to Make a Better Planet</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>82-361 Introduction to Italian Culture</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>82-362 Italian Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>Thesis</td>
<td>82-475 Topics in German Literature and Culture</td>
<td>9</td>
</tr>
</tbody>
</table>

*Spring semester of the junior year is a popular semester for study abroad. However, Global Studies majors may instead choose to study abroad in spring of the sophomore year, fall of junior year, or fall of senior year. Students should discuss study abroad and curricular planning with the academic advisor.

**Students are not required to complete a college honors thesis. However, many Global Studies majors choose to apply for the senior honors thesis.
The program. Students who do not pursue a senior honors thesis should select an elective in its place.

Additional Major
Global Studies may be elected as a primary or an additional major; the requirements for each are the same. Contact the academic advisor (see contact information above) to elect the additional major.

The Major in Ethics, History, and Public Policy
Faculty Advisor: Jay Aronson
Office: Baker Hall 246B, 412/268-2887
Email: aronson@andrew.cmu.edu

The B.A./B.S. in Ethics, History, and Public Policy is an interdepartmental major offered jointly by the Departments of History and Philosophy. It prepares students for leadership positions in law, public policy, ethics, and advocacy by providing them with a rigorous, interdisciplinary humanistic and social-scientific education. It also serves as an excellent spring board for graduate study in a wide variety of disciplines. The program focuses equally on the historical understanding of how modern-day problems have evolved, and the importance of developing clear criteria for ethical decision-making. The capstone project course provides students with the opportunity to engage with real-world public policy challenges using the methods, theories and knowledge that they have gained through the major. Offered jointly by the departments of History and Philosophy, the B.A./B.S. in EHPP encourages specialization, internship experiences, and research in a wide range of policy areas.

Curriculum
Students graduating with a primary major in Ethics, History, and Public Policy may elect to receive either a Bachelor of Arts or a Bachelor of Science Degree (additional requirements apply; see below). Basic requirements include 123 units encompassing 9 units in Economics, 39 units in History, 36 units in Philosophy, 27 units of elective courses, and a 12-unit, senior capstone course. This program may also be taken as an additional (e.g., second) major.

I. Economics Requirement 9 units
Choose one of the following:
73-100 Principles of Economics 9
88-220 Policy Analysis I 9

II. History Core 39 units
Choose one 9-unit course from each category below:
Policy History (9 units)
79-300 History of American Public Policy 9
U.S. History (9 units)
79-240 The Development of American Culture 9
79-249 20th Century U.S. 9
Non-U.S. History (9 units)
79-205 20th Century Europe 9
79-207 Development of European Culture 9
79-220 Caribbean: Cultures and Histories 9
79-222 Between Revolutions: The Development of Modern Latin America 9
79-226 Introduction to African History: Earliest Times to 1780 9
79-227 Introduction to African History: 1780-1994 9
79-307 Religion and Politics in the Middle East 9
79-261 Chinese Culture and Society 9
79-265 Russian History: From the First to the Last Tsar 9
79-266 Russian History: From Communism to Capitalism 9

Historical Methods and Approaches (12 units)
79-360 Historical Evidence and Interpretation 12

III. Philosophy Core 36 units
Choose one 9-unit course from each category below. No more than 18 units at the 100 level may be counted toward this requirement.

Ethics (9 units)
80-130 Introduction to Ethics 9
80-230 Ethical Theory 9

Political Philosophy (9 units)
80-135 Introduction to Political Philosophy 9
80-235 Political Philosophy 9

Foundations of Social Science (9 units)
80-221 Philosophy of Social Science 9
80-321 Causation, Law, and Social Policy 9
80-337 Philosophy Politics & Economics 9

Applied Philosophy (9 units)
80-126 Social Structure, Public Policy & Ethics 9
80-243 Ethical Judgments in Professional Life 9
80-244 Environmental Ethics 9
80-245 Medical Ethics 9
80-247 Ethics and Global Economics 9
80-341 Computers, Society and Ethics 9
80-344 Management, Environment, and Ethics 9
80-348 Health Development and Human Rights 9
80-447 Global Justice 9

IV. Senior Capstone Project Course (79/80-449) 12 units
The Ethics, History and Public Policy Project Course is required for the Ethics, History and Public Policy major and is taken in the fall semester of the senior year. In this capstone course, Ethics, History and Public Policy majors carry out a collaborative research project that examine a compelling current policy issue that can be illuminated with historical research and philosophical and policy analysis. The students develop an original research report based on both archival and contemporary policy analysis and they present their results to a client organization in the community.

V. Elective Courses 27 units
Choose any three courses from any category or categories shown below.

Engineering and Public Policy (some courses have prerequisites; see EPP catalog listing)
19-424 Energy and the Environment 9
19-426 Environmental Decision Making 9
19-448 Science, Technology & Ethics 9

Business
70-311 Organizational Behavior 9
70-321 Negotiation and Conflict Resolution 9
70-332 Business, Society and Ethics 9
70-364 Business Law 9
70-365 International Trade and International Law 9
70-430 International Management 9

Economics (some courses have prerequisites; see Economics catalog listing)
73-148 Environmental Economics 9
73-310 Evolution of Economic Ideas and Analysis 9
73-351 Public Finance 9
73-357 Regulation: Theory and Policy 9
73-358 Economics of the Environment and Natural Resources 9
73-359 Benefit-Cost Analysis 9
73-365 Firms, Market Structures, and Strategy 9
73-371 International Trade and Economic Development 9
73-372 International Money and Finance 9
73-375 History of Money and Monetary Policy 9
73-408 Law and Economics 9
73-476 American Economic History 9

English
76-492 Rhetoric of Public Policy 9

History
Courses from the EHPP History Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.
79-221 Development and Democracy in Latin America 9
79-231 American Foreign Policy 1945-Present 9
79-233 The United States and the Middle East since 1945 9
79-242 Topics in African American History: Reconstruction to the Present 9
79-267 The Soviet Union in World War II: Military, Political, and Social History 9
79-303 Pittsburgh and the Transformation of Modern Urban America 9
79-305 Juvenile Delinquency/Images, Realities, Public Policy, 1800-1967 9
79-306 Delinquency, Crime, and Juvenile Justice: 1970s to the Present 9
79-320 Women, Politics, and Protest 9
79-331 Body Politics: Women and Health in America 9
79-333 Biology and Society: Evolutionary Animal Experimentation and Eugenics 9
79-334 Law, Ethics, and the Life Sciences 9
79-335 Drug Use and Drug Policy 9
79-338 Education and Social Reform 9
79-339 Juvenile Delinquency Through Film 9
79-342 Introduction to Science and Technology Studies 9
79-359 Sustainable Innovations: Ideas, Policies & Technologies to Make a Better Planet 9
79-368 Poverty, Charity, and Welfare 9
79-371 African American Urban History 9
79-374 American Environmental History: Critical Issues 9
Courses from the EHPP Philosophy Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.

**Philosophy**

**Introductory Courses (18 units)**

Complete two courses.

- 79-207 Development of European Culture 9
- 79-220 Caribbean: Cultures and Histories 9
- 79-222 Between Revolutions: The Development of Modern Latin America 9
- 79-226 Introduction to African History: Earliest Times to 1780 9
- 79-227 Introduction to African History: 1780-1944 9
- 79-240 The Development of American Culture 9
- 79-261 Chinese Culture and Society 9
- 79-265 Russian History: From the First to the Last Tsar 9

**Advanced Courses (36 units)**

Complete four courses numbered between 79-202 and 79-354. Courses numbered 79-361 and above may be taken only with special permission.

**Faculty**

- CAROLINE ACKER, Associate Professor of History; Head, Department of History – Ph.D., University of California, San Francisco; Carnegie Mellon, 1993–.
- JAY D. ARONSON, Associate Professor of History – Ph.D., University of Minnesota; Carnegie Mellon, 2004–.
- ALLYSON F. CREAMAN, Associate Professor of History – Ph.D., University of Virginia; Carnegie Mellon, 2005–.
- LAURIE Z. EISENBERG, Teaching Professor of History – Ph.D., University of Michigan; Carnegie Mellon, 1992–.
- PAUL EISS, Associate Professor of Anthropology and History – Ph.D., University of Michigan; Carnegie Mellon, 2000–.
- EDDA FIELDS-BLACK, Associate Professor of History – Ph.D., University of Pennsylvania; Carnegie Mellon, 2001–.
- WENDY Z. GOLDMAN, Professor of History – Ph.D., University of Pennsylvania; Carnegie Mellon, 1988–.
- DONNA HARSH, Professor of History – Ph.D., Yale University; Carnegie Mellon, 1990–.
- KATHERINE A. LYNCH, Professor of History; Director of Graduate Studies, Department of History – Ph.D., Harvard University; Carnegie Mellon, 1990–.
- RICHARD MADDOX, Professor of Anthropology and History – Ph.D., Stanford University; Carnegie Mellon, 1993–.
- DAVID W. MILLER, Professor Emeritus of History – Ph.D., University of Chicago; Carnegie Mellon, 1967–.
- BENJAMIN REILLY, Associate Teaching Professor of History, Qatar Campus – Ph.D., University of Pittsburgh; Carnegie Mellon, 2004–.
- ROGER ROUSE, Associate Teaching Professor of History – Ph.D., Stanford University; Carnegie Mellon, 2006–.
- SCOTT A. SANDAGE, Associate Professor of History; Director of Undergraduate Studies, Department of History – Ph.D., Rutgers University; Carnegie Mellon, 1995–.
- JUDITH SCHARZTZER, Professor of Anthropology and History – Ph.D., University of Minnesota; Carnegie Mellon, 1994–.
- STEVEN SCHLOSSMAN, Professor of History – Ph.D., Columbia University; Carnegie Mellon, 1988–.
- NICO SLATE, Assistant Professor of History – Ph.D., Harvard University; Carnegie Mellon, 2009–.
- JOHN SOLURI, Associate Professor of History – Ph.D., University of Michigan; Carnegie Mellon, 1999–.
- DONALD S. SUTTON, Professor of History and Anthropology – Ph.D., Cambridge University, England; Carnegie Mellon, 1969–.
- JOEL A. TARR, Richard S. Caliguiri University Professor – Ph.D., Northwestern University; Carnegie Mellon, 1985–.
- JOE WILLIAM TROTTER, Giant Eagle Professor of History and Social Justice – Ph.D., University of Minnesota; Carnegie Mellon, 1985–.
Adjunct Faculty

JOSEPH E. DEVINE, Adjunct Professor of History; Associate Dean for Undergraduate Studies, Dietrich College of Humanities and Social Sciences – D.A., Carnegie Mellon University; Carnegie Mellon, 1979–.

KAREN FAULK, Visiting Assistant Professor – Ph.D., University of Michigan; Carnegie Mellon, 2009–.

TIMOTHY HAGGERTY, Adjunct Professor of History; Director of the Humanities Scholars Program – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000–.

NAUM KATS, Adjunct Professor of History – Ph.D., University of Saint Petersburg; Carnegie Mellon, 1990–.

AFEWORKI PAULOS, Adjunct Professor of History – Ph.D., George Washington University; Carnegie Mellon, 2009–.

AARON SHKUDA, ACLS New Faculty Fellow – Ph.D., University of Chicago; Carnegie Mellon, 2011–.
The Major in Information Systems

Faculty Program Director: Randy S. Weinberg
Office: Porter Hall 222
http://www.cmu.edu/information-systems/

Information Systems (IS), found within the Dietrich College of Humanities and Social Sciences, is an internationally recognized undergraduate major for students who want to design and implement effective solutions to meet organizational, societal and management needs for information and decision support.

In today’s complex, interconnected world, the effective creation, distribution, and use of information via technology is central to daily life. Computer based information systems facilitate, enable and often define the relationships between corporations and consumers, buyers and suppliers, businesses of all sizes, social networks, and citizens and their governments. Understanding these relationships and effectively addressing the collection, flow, and distribution of information is vital to running a modern organization, enterprise or government agency.

Information Systems involves the effective design, delivery, use and impact of information and communications technologies in organizations and society. The importance of information technology and information systems to organizations and the need for well-educated professionals in the field is the basis for the Information Systems curriculum at Carnegie Mellon. Whether implementing applications, providing management or decision support, managing complex systems projects, or helping organizations design business processes or cope with rapid change, IS professionals fill an essential need across all sectors of society.

Information systems students at Carnegie Mellon learn to use, manage and deploy information technologies to address real problems or opportunities. They develop a solid foundation in computing, communications, and software development principles, languages, methods. Since Information Systems generally operate within organizations, IS students study social sciences and organizational theory. IS students learn how to size, design information technology enabled solutions to meet real-world economic and organizational constraints. Information Systems students also learn, through hands-on experience, the critical importance of professional communications, problem analysis, critical thinking and teamwork. Building on the multi-disciplinary strengths of the university and the Dietrich College of Humanities and Social Sciences, graduates in Information Systems are ideally suited to take a leading role in shaping our information-based future.

The flexible nature of the program encourages students to explore their own interests through program electives, study in a contemporary content area or through optional second majors and minors.

IS students are well prepared to pursue graduate work in a wide range of fields. For students interested in master’s degree-level graduate work at Carnegie Mellon, there are many possibilities, including accelerated Masters degree programs in Information Systems Management, Human Computer Interaction, Information Security Policy and Management, Engineering Technology and Innovation Management, and Business Administration.

IS graduates continue to be in high demand in the information-age workplace. There has been a strong job market for IS students in recent years, and national trends indicate that this is likely to continue. IS majors often take jobs in consulting companies, major software firms, large corporations, and start-up companies. Internship opportunities closely parallel the job market.

In addition to the Dietrich College General Education Requirements and basic prerequisites in Mathematics, Statistics and Computer Science, IS students must complete the Professional Core, the Disciplinary Core and a focused Content Area. In the Professional Core (consisting of six courses), students learn the basic skills necessary to analyze, design, implement and test high-quality, cost effective information systems. Two of the Professional Core courses are project-based experiences in which small teams of students develop and deliver solutions to real information problems.

In the Disciplinary Core (consisting of three courses), students study key areas fundamental to understanding and solving problems in information systems: professional communications; quantitative analysis and research methods; and organizations, policy, and social science. IS students also complete three courses within one Content Area. The content areas are designed to provide students an opportunity to gain additional depth in a focused area. Current content areas are:

- Business / Enterprise Systems
- Computing and Information Systems & Technology
- Social and Global Systems
- Quantitative Analysis and Research Methods

**Study Abroad Options in Information Systems**

Given the rise of globalization and its effect on information systems development, we encourage students to consider expanding their international experience by spending a semester studying abroad. The IS program is very flexible in allowing students to pursue these opportunities, and we have a number of strategic alliances with overseas universities to make it easy for students to find courses that will count towards major requirements. With careful planning, study abroad is possible during most semesters. Students interested in study abroad should talk with the IS academic advisor to help plan an appropriate course of study. With prior approval, study abroad courses may be applied to major requirements.

**Information Systems as Additional Major or Minor**

Information Systems is not available as either an additional major or minor.

**Transfer into Information Systems**

Most IS students are admitted directly into Information Systems as incoming freshmen. Only Information Systems major students are permitted to enroll in the Professional Core courses (67-272 and above), and IS students have enrollment priority in IS electives.

Students in good academic standing may apply to be admitted to the Information Systems major as transfer students. Students accepted as transfers to the IS program would normally be expected to complete the usual prerequisites and begin the Professional Core courses during the next available semester. Applications for admission to the major are considered at mid-semester and at the end of each semester.

Undergraduate students in other Carnegie Mellon colleges who wish to transfer to the Dietrich College and then into Information Systems should apply through the Dietrich College Academic Advisory Center (http://www.cmu.edu/hss/advisory-center/transferring/transfer-in.html). Baker Hall A57. Students must be approved for admission to both the Dietrich College and Information Systems. Decisions regarding transfer requests will be based on evidence of adequate prior academic performance and on the applicant’s prospects for success in the Information Systems major.

Students interested in applying for transfer to the Information Systems major should contact the IS academic advisor for information regarding availability, application procedures and deadlines. Potential applicants to the IS major should be working toward a sensible alternative major, so that their success at Carnegie Mellon is not predicated on admission to the IS program.

**Curriculum**

The Information Systems major is offered only as a Bachelor of Science (B.S.) degree. In addition to major requirements outlined below, all Information Systems students must fulfill the General Education requirements for the Dietrich College of Humanities and Social Sciences. A total of 360 units is required for the degree.

Requirements are subject to revision. Advisor approval is required for each student’s major curriculum plan. Any proposed course substitutions to courses required for the IS major must be approved in advance by the IS academic advisor.

**Prerequisites**

Information Systems requires completion of prerequisite courses in Mathematics, Statistics and Computer Science. All prerequisites must be successfully completed prior to the start of Fall semester, junior year.

**Mathematics and Statistics**

Complete one of the following calculus sequences:

<table>
<thead>
<tr>
<th>Units</th>
<th>Description</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Calculus I</td>
<td>21-111</td>
</tr>
<tr>
<td>10</td>
<td>Calculus II</td>
<td>21-112</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Differential and Integral Calculus</td>
<td>21-120</td>
</tr>
<tr>
<td></td>
<td>Multivariate Analysis (Required for advanced business courses)</td>
<td>21-256</td>
</tr>
</tbody>
</table>
students see that the structure and presentation of information affects how well (and how easily) it can be understood and used.

Complete one course (it is recommended that this requirement be completed by the end of junior year):

15-221 Technical Communication for Computer Scientists 9
36-315 Statistical Graphics and Visualization 9
51-261 Communication Design Fundamentals 9
or 51-262 Communication Design Fundamentals 9
70-321 Negotiation and Conflict Resolution 9
70-340 Business Communications 9
70-342 Managing Across Cultures 9
76-270 Writing for the Professions 9
80-291 Issues in Multimedia Authoring 9
88-341 Organizational Communication 9
or 70-341 Organizational Communication 9

Quantitative Analysis and Research Methods

This area focuses on decision making and data analysis - essential to development of useful information systems. This area exposes students to analytic methods in the social sciences and quantitative methods for approaching complex methods.

Complete one course (it is recommended that this requirement be completed in the sophomore year):

21-257 Models and Methods for Optimization 9
36-202 Statistical Methods 9
36-208 Regression Analysis 9
or 70-208 Regression Analysis 9
36-303 Sampling, Survey and Society 9
36-309 Experimental Design for Behavioral and Social Sciences 9
67-360 Applied Analytics 9
67-370 Intelligent Decision Support Systems 9
80-305 National Choice 9
80-405 Game Theory 9
88-223 Decision Analysis and Decision Support Systems 9
88-251 Empirical Research Methods 9

Organizations, Policy, and Social Science

The focus of this area is on how organizations function in modern social and economic environments. Students will develop a greater understanding of how social policy and technology influence organizations and how they operate.

Complete one course:

15-390 Entrepreneurship for Computer Science 9
19-402 Telecommunications, Technology Policy & Management 12
19-403 Policies of Wireless Systems and the Internet 12
19-411 Global Competitiveness: Firms, Nations and Technological Change 9
19-601 Information Warfare 12
67-344 Organizational Intelligence in the Information Age 9
70-311 Organizational Behavior 9
70-332 Business, Society and Ethics 9
70-341 Organizational Communication 9
or 88-341 Organizational Communication 9
70-342 Managing Across Cultures 9
70-414 Technology Based Entrepreneurship for CIT 9
70-415 Introduction to Entrepreneurship 9
70-421 Entrepreneurship for Computer Scientists 9
80-341 Computers, Society and Ethics 9
88-220 Policy Analysis I 9
88-223 Decision Analysis and Decision Support Systems 9
88-260 Organizations 9

Content Area

Complete a minimum of 27 units from one of the four Content Areas below. No Content Area course may also be used to fulfill a Disciplinary Core or Professional Core requirement.

Business/Enterprise Systems

This content area broadens a student’s knowledge in the business, economics and policy aspects of large scale information systems.

19-402 Telecommunications, Technology Policy & Management 12
19-411 Global Competitiveness: Firms, Nations and Technological Change 9
19-601 Information Warfare 12
67-260 Visualizing Complex Information 6
67-301 Networks and Telecommunications 6
67-306 Special Topics: Management of Computer and Information Systems 6
67-309 Special Topics 6
67-311 Database Design and Implementation 9
67-328 Mobile to Cloud: Developing Distributed Applications 9
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-330</td>
<td>Technology Consulting in the Community</td>
<td>9</td>
</tr>
<tr>
<td>67-331</td>
<td>Technology Consulting in the Global Community</td>
<td>3</td>
</tr>
<tr>
<td>67-344</td>
<td>Organizational Intelligence in the Information Age</td>
<td>9</td>
</tr>
<tr>
<td>67-370</td>
<td>Intelligent Decision Support Systems</td>
<td>9</td>
</tr>
<tr>
<td>70-332</td>
<td>Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>70-366</td>
<td>Intellectual Property and E-Commerce</td>
<td>6</td>
</tr>
<tr>
<td>70-371</td>
<td>Technology Based Entrepreneurship for CIT</td>
<td>9</td>
</tr>
<tr>
<td>70-415</td>
<td>Introduction to Entrepreneurship</td>
<td>9</td>
</tr>
<tr>
<td>70-421</td>
<td>Entrepreneurship for Computer Scientists</td>
<td>9</td>
</tr>
<tr>
<td>70-455</td>
<td>Information Resource Management</td>
<td>9</td>
</tr>
<tr>
<td>70-460</td>
<td>Mathematical Models for Consulting</td>
<td>9</td>
</tr>
<tr>
<td>70-465</td>
<td>Technology Strategy</td>
<td>9</td>
</tr>
<tr>
<td>70-471</td>
<td>Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>73-359</td>
<td>Benefit-Cost Analysis</td>
<td>9</td>
</tr>
<tr>
<td>73-469</td>
<td>Global Electronic Markets: Economics and the Internet</td>
<td>9</td>
</tr>
<tr>
<td>76-391</td>
<td>Document Design</td>
<td>12</td>
</tr>
<tr>
<td>76-487</td>
<td>Web Design</td>
<td>9</td>
</tr>
</tbody>
</table>

**Computing and Information Systems & Technology**

This content area allows students to focus on current and emerging technologies.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-391</td>
<td>Designing Human Centered Software</td>
<td>12</td>
</tr>
<tr>
<td>05-410</td>
<td>User-Centered Research and Evaluation</td>
<td>12</td>
</tr>
<tr>
<td>05-430</td>
<td>Programming Usable Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>05-431</td>
<td>Software Structures for User Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>16-311</td>
<td>Introduction to Robotics</td>
<td>12</td>
</tr>
<tr>
<td>16-362</td>
<td>Mobile Robot Programming Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>19-403</td>
<td>Policies of Wireless Systems and the Internet</td>
<td>12</td>
</tr>
<tr>
<td>19-411</td>
<td>Global Competitiveness: Firms, Nations and Technological Change</td>
<td>9</td>
</tr>
<tr>
<td>60-415</td>
<td>Advanced ETB: Animation</td>
<td>10</td>
</tr>
<tr>
<td>67-311</td>
<td>Database Design and Implementation</td>
<td>9</td>
</tr>
<tr>
<td>67-327</td>
<td>Web Application Security</td>
<td>6</td>
</tr>
<tr>
<td>67-328</td>
<td>Mobile to Cloud: Developing Distributed Applications</td>
<td>9</td>
</tr>
</tbody>
</table>

Any 15-xxx course above 15-121 with prerequisite of 15-112 or higher

**Social and Global Systems**

This content area exposes students to key themes in globalization and global systems – management, policy, international business, and technology.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-402</td>
<td>Telecommunications, Technology Policy &amp; Management</td>
<td>12</td>
</tr>
<tr>
<td>19-403</td>
<td>Policies of Wireless Systems and the Internet</td>
<td>12</td>
</tr>
<tr>
<td>19-411</td>
<td>Global Competitiveness: Firms, Nations and Technological Change</td>
<td>9</td>
</tr>
<tr>
<td>19-601</td>
<td>Information Warfare</td>
<td>12</td>
</tr>
<tr>
<td>67-260</td>
<td>Visualizing Complex Information</td>
<td>6</td>
</tr>
<tr>
<td>67-329</td>
<td>Contemporary Themes in Global Systems</td>
<td>9</td>
</tr>
<tr>
<td>67-330</td>
<td>Technology Consulting in the Community</td>
<td>9</td>
</tr>
<tr>
<td>67-331</td>
<td>Technology Consulting in the Global Community</td>
<td>3</td>
</tr>
<tr>
<td>70-342</td>
<td>Managing Across Cultures</td>
<td>9</td>
</tr>
<tr>
<td>70-365</td>
<td>International Trade and International Law</td>
<td>9</td>
</tr>
<tr>
<td>70-430</td>
<td>International Management</td>
<td>9</td>
</tr>
<tr>
<td>70-480</td>
<td>International Marketing</td>
<td>9</td>
</tr>
<tr>
<td>73-371</td>
<td>International Trade and Economic Development</td>
<td>9</td>
</tr>
<tr>
<td>73-372</td>
<td>International Money and Finance</td>
<td>9</td>
</tr>
<tr>
<td>76-318</td>
<td>Communicating in the Global Marketplace</td>
<td>9</td>
</tr>
<tr>
<td>76-386</td>
<td>Language &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>79-318</td>
<td>Sustainable Social Change: History and Practice</td>
<td>9</td>
</tr>
<tr>
<td>79-381</td>
<td>Energy, Environment, Globalization in the Americas</td>
<td>9</td>
</tr>
<tr>
<td>88-326</td>
<td>Theories of International Relations</td>
<td>9</td>
</tr>
<tr>
<td>88-359</td>
<td>Globalization</td>
<td>9</td>
</tr>
<tr>
<td>88-371</td>
<td>Entrepreneurship, Regulation and Technological Change</td>
<td>9</td>
</tr>
<tr>
<td>88-378</td>
<td>International Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-384</td>
<td>Conflict and Conflict Resolution in International Relations</td>
<td>9</td>
</tr>
<tr>
<td>88-391</td>
<td>Technology and Economic Growth</td>
<td>9</td>
</tr>
<tr>
<td>88-411</td>
<td>The Rise of the Asian Economies</td>
<td>9</td>
</tr>
</tbody>
</table>

**QUALITATIVE ANALYSIS AND RESEARCH METHODS**

Students will learn to apply analytic and quantitative methods for approaching complex, ambiguous problems.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-257</td>
<td>Models and Methods for Optimization</td>
<td>9</td>
</tr>
<tr>
<td>21-292</td>
<td>Operations Research I</td>
<td>9</td>
</tr>
<tr>
<td>36-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 70-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-303</td>
<td>Sampling, Survey and Society</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
<tr>
<td>36-350</td>
<td>Statistical Computing</td>
<td>9</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
<td>9</td>
</tr>
</tbody>
</table>

**DOUBLE COUNTING OF COURSES**

“Double Counting” refers to instances when a course taken to fulfill one requirement counts simultaneously toward a requirement in another major or minor program. Double Counting is permitted in the Dietrich College on a very limited basis. Information Systems students may double count no more than two courses used to fulfill any Information Systems major requirement (beyond the Dietrich College General Education requirements and Prerequisite courses) with any combination of additional majors, minors or graduate degree programs. Only one course may double count with any minor. No course can count for more than one requirement within the major. Students must also adhere to any policy restrictions on double counting enforced by the academic department of the student’s additional major or minor.

**Information Systems Sample Curriculum**

### Freshman Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>9</td>
</tr>
<tr>
<td>19-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td>9</td>
</tr>
<tr>
<td>21-111</td>
<td>Calculus I</td>
<td>9</td>
</tr>
<tr>
<td>21-112</td>
<td>Calculus II</td>
<td>9</td>
</tr>
<tr>
<td>21-257</td>
<td>Information Systems</td>
<td>9</td>
</tr>
</tbody>
</table>

### Sophomore Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112</td>
<td>Introduction to Data Structures</td>
<td>9</td>
</tr>
<tr>
<td>67-250</td>
<td>Information Systems</td>
<td>9</td>
</tr>
</tbody>
</table>

### Senior Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-272</td>
<td>Application Design and Development</td>
<td>9</td>
</tr>
</tbody>
</table>

### Junior Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-371</td>
<td>Fundamentals of System Development</td>
<td>9</td>
</tr>
<tr>
<td>67-372</td>
<td>Development Project</td>
<td>9</td>
</tr>
</tbody>
</table>

### Senior Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-475</td>
<td>Information Systems</td>
<td>9</td>
</tr>
</tbody>
</table>

### Junior Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-272</td>
<td>Application Design and Development</td>
<td>9</td>
</tr>
</tbody>
</table>

**Faculty**

C.F. LARRY HEIMANN, Teaching Professor – Ph.D., Washington University (St. Louis); Carnegie Mellon, 1999–.

J. OSEPH S. MERTZ, Associate Teaching Professor (joint Appointment with Heinz College) – Ph.D., Carnegie Mellon University: Carnegie Mellon, 1997–.

J.ANNA QUESBERRY, Assistant Teaching Professor – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.

RAJA SODIAMIURTHI, Associate Teaching Professor – Ph.D., Indiana University; Carnegie Mellon, 2007–.

RANDY S. WEINBERG, Teaching Professor; Program Director, Information Systems – Ph.D., University of Minnesota; Carnegie Mellon, 1998–.
Department of Modern Languages

Susan G. Polansky, Department Head
Christian Hallstein, Director of Undergraduate Studies
Department Office: Baker Hall 160
http://ml.hss.cmu.edu/ml/

The study of a foreign language is not only desirable but essential for successful integration into our multinational, pluralistic world. It is crucial to educate global citizens who will be sensitive to other cultures and capable of communicating in other languages. Proficiency in a foreign language by itself, or combined with other professional training, may lead to a variety of rewarding careers. Moreover, the personal experience of mastering another language is enriching and gratifying.

The Majors in Chinese Studies, French & Francophone Studies, German Studies, Hispanic Studies, Japanese Studies, and Russian Studies

These majors are designed to lead to acquisition of communicative language proficiency and substantive knowledge of other cultures. In addition, the Department offers an interdepartmental major in European Studies.

Drawing on the unique interdisciplinary climate of the Carnegie Mellon campus, the undergraduate majors in Modern Languages encourage the acquisition of multiple skills by students with varied backgrounds, talents, and interests. An important resource in support of these goals is the Modern Language Resource Center (MLRC), a state-of-the-art facility that provides students with access to authentic foreign language materials such as original television broadcasts, interactive video projects, Technology Enhanced Language Learning (TELL) courses, international audio and video resources, and computerized assessment tools.

Students majoring in a modern language are also encouraged to enroll, preferably during their junior year, in a study-abroad program or to spend a summer abroad at a language institute or in an internship. Semester or year-long programs are available in places such as China, France, Germany, Japan, Africa, Russia, Spain, and Latin America. The Department also sponsors summer courses in China, Germany, and Spain (see http://ml.hss.cmu.edu/ml/). Foreign film series, informal conversation tables, native-speaker conversation partners, speaking and writing assistants, and Student Advisory Committee cultural events are some of the activities organized by the Department of Modern Languages to increase students' ability in languages and knowledge of cultures.

The major in Modern Languages is designed to permit students to acquire communicative language proficiency in their language of specialization. Courses in culture and civilization offer students a solid introduction to the main currents in national literatures as well as artistic and social movements. These courses integrate study of cultures with skill development in reading, writing, and aural/oral communication. In addition, the student who majors in Modern Languages will develop a perspective on the learning and use of second languages, from both a social and cognitive point of view, within contemporary American society and in an increasingly global community. Working closely with their advisor, language majors are guided to develop personal interests by taking courses in other disciplines such as fine arts, history, psychology, philosophy, and other humanities and social sciences, which often include readings, discussions, and papers in the foreign language. The rich technological environment of the campus strongly enhances all fields of language study.

Second language proficiency is seen as an asset which enhances the study of all other fields and which will provide students with practical as well as theoretical bases for a variety of paths after graduation. Students will be prepared to pursue graduate studies in second language-related fields (e.g. linguistics, literature, second language acquisition) or they may use their undergraduate background as a complement to careers in fields such as the arts, government or public service, volunteer work, technology, business and management, law, and other areas in which proficiency in a second language and knowledge of other cultures is an asset.

Curriculum

Seven specializations are available in the Department of Modern Languages: Chinese Studies, French and Francophone Studies, German Studies, Hispanic Studies, Japanese Studies, and Russian Studies, as well as European Studies. Language-specific faculty advisors for these majors are:

**Chinese Studies**- Elisabeth Kaske, Assistant Professor of Chinese Studies and Yueming Yu, Teaching Professor of Chinese Studies

**French & Francophone Studies**-Bonnie Youngs, Teaching Professor of French & Francophone Studies

**German Studies**-Stephen Brockmann, Professor of German

**Hispanic Studies**-Kenya C. Dworkin (Hispanic Studies), Chris Hallstein (German), or Bonnie Youngs (French & Francophone Studies)

**Japanese Studies**-Keiko Koda, Professor of Japanese and Second Language Acquisition, and Yasufumi Iwasaki, Associate Teaching Professor of Japanese

**European Studies**-Kenya C. Dworkin (Hispanic Studies), Chris Hallstein (German), or Bonnie Youngs (French & Francophone Studies)

**Russian Studies**-Charlene Castellano, Teaching Professor of Russian

* The major in European Studies is an interdepartmental major offered jointly with the Department of History. This major is described in the H&SS Interdepartmental Majors section of the catalog.

The Major in Chinese Studies 96-99 units

Students may enter their major and begin major course requirements when they have met the prerequisites described below. Should they desire, students should also be able to complete an additional major or minor.

Prerequisites 0-36 units

Students need to complete Elementary Chinese I & II (82-131 & 82-132) and Intermediate Chinese I (82-231) courses, or Intensive Elementary Chinese (82-135). Exemption from these courses can be granted based on Advanced Placement, International Baccalaureate, or Carnegie Mellon internal placement test results.

1. Core Courses in Chinese Studies 39-42 units*

Complete all four courses

- 82-232 Intermediate Chinese I ** 12
- 82-331 Advanced Chinese I 9
- 82-322 Advanced Chinese II 9
- 82-333 Introduction to Chinese Language and Culture 3

* Placement out of 82-232 is possible. Students who place out of 82-232 will need to take one more course at the 300-level with a minimum of 9 units. Then the total credits for this category will be 39. The selection should be made between the following two courses based on the specific needs of each individual student:

- 82-335 Readings in Chinese 9
- 82-337 Mandarin Chinese for Oral Communication 9

** 82-235 Intensive Intermediate Chinese may substitute for this course.

2. Core Courses in Modern Languages 12 units

Complete one 9 unit course plus the Senior Seminar

- 82-280 Learning About Language Learning 9
- 82-281 Tutoring for Community Outreach Var
- 82-358 Literacies Across Language and Culture 9
- 82-383 Second Language Acquisition: Theories and Research 9
- 82-388 Understanding Second Language Fluency 9
- 82-580 Senior Seminar in Modern Languages 3

* In consultation with the Major Advisor, students may substitute a course related to language analysis or from the listings in Chinese from another department. Examples: 82-182 Language Development: Bilingualism, 82-180 Nature of Language, 82-421 Language and Thought.

3. Core course(s) in History & Society min. 9 units

Complete one of the following History courses after consultation with the Major Advisor and the designated History or Modern Languages professor.

- 79-212 China and Its Neighbors: Minorities, Conquerors and Tributary Bearers 9
- 79-261 Chinese Culture and Society 9
- 79-262 Modern China 9
- 79-308 18th Century China Through Literature 9
4. Chinese Studies and Interdisciplinary Electives min. 36 units

Complete two courses from List A and two courses from List B, or two courses from List A, one course from List B and one course from List C.

List A: Core Chinese Studies Electives (minimum) 18 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-337 Mandarin Chinese for Oral Communication</td>
<td>9</td>
</tr>
<tr>
<td>82-335 Readings in Chinese</td>
<td>9</td>
</tr>
<tr>
<td>82-337 Mandarin Chinese for Oral Communication</td>
<td>9</td>
</tr>
<tr>
<td>82-338 Mandarin Chinese for Oral Communication</td>
<td>9</td>
</tr>
<tr>
<td>82-432 Popular Culture in China</td>
<td>9</td>
</tr>
<tr>
<td>82-439 Modern China Through Literature Var.</td>
<td>9</td>
</tr>
<tr>
<td>82-439 Modern China Through Literature Var.</td>
<td>9</td>
</tr>
<tr>
<td>82-440 Studies in Chinese Literature &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-443 Topics in Contemporary Culture of China</td>
<td>9</td>
</tr>
<tr>
<td>82-444 Studies in Chinese Traditions *</td>
<td>9</td>
</tr>
<tr>
<td>82-456 Introduction to Classical Chinese</td>
<td>9</td>
</tr>
<tr>
<td>82-531/532 Special Topics Chinese</td>
<td>3</td>
</tr>
</tbody>
</table>

List B: Chinese Studies Electives (minimum) 9 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-334 Structure of Chinese</td>
<td>9</td>
</tr>
<tr>
<td>82-335 Readings in Chinese</td>
<td>9</td>
</tr>
<tr>
<td>82-337 Mandarin Chinese for Oral Communication</td>
<td>9</td>
</tr>
<tr>
<td>82-338 Mandarin Chinese for Oral Communication</td>
<td>9</td>
</tr>
<tr>
<td>82-432 Popular Culture in China</td>
<td>9</td>
</tr>
<tr>
<td>82-439 Modern China Through Literature Var.</td>
<td>9</td>
</tr>
<tr>
<td>82-440 Studies in Chinese Literature &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-443 Topics in Contemporary Culture of China</td>
<td>9</td>
</tr>
<tr>
<td>82-444 Studies in Chinese Traditions *</td>
<td>9</td>
</tr>
<tr>
<td>82-456 Introduction to Classical Chinese</td>
<td>9</td>
</tr>
<tr>
<td>82-531/532 Special Topics Chinese</td>
<td>3</td>
</tr>
</tbody>
</table>

* Students may repeat with new topics.

List C: Interdisciplinary Electives 9 units

Students should consult OLR and their advisor for the most up to date interdisciplinary electives appropriate for the Chinese major curriculum. These electives should contain a component related to the Chinese major.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-351 Human Factors in Architecture</td>
<td>9</td>
</tr>
<tr>
<td>48-551 Ethics and Decision Making in Architecture</td>
<td>9</td>
</tr>
<tr>
<td>60-373 Aesthetics from a Global Viewpoint</td>
<td>9</td>
</tr>
<tr>
<td>60-399 Art History/Theory Independent Study</td>
<td>9</td>
</tr>
<tr>
<td>70-342 Managing Across Cultures</td>
<td>9</td>
</tr>
<tr>
<td>70-365 International Trade and International Law</td>
<td>9</td>
</tr>
<tr>
<td>70-430 International Management</td>
<td>9</td>
</tr>
<tr>
<td>76-318 Communicating in the Global Marketplace</td>
<td>9</td>
</tr>
<tr>
<td>76-339 Advanced Film and Media Studies</td>
<td>9</td>
</tr>
<tr>
<td>76-386 Language &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>76-387 Narrative &amp; Argument</td>
<td>9</td>
</tr>
</tbody>
</table>

5. Oral Proficiency Interview

Complete an oral proficiency interview with a faculty member in Chinese. This exam should be taken by the end of the first semester of the senior year.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

Chinese Studies (B.A.) Sample Curriculum

This sample curriculum assumes that all prerequisites for 82-331 are fulfilled prior to the junior year.

### Junior Year

**Fall**
- 82-331 Advanced Chinese I
- 82-332 Advanced Chinese II
- 82-333 Introduction to Chinese Language and Culture
- 82-332 Advanced Chinese II
- 82-333 Introduction to Chinese Language and Culture
- 82-334 Readings in Chinese
- 82-337 Mandarin Chinese for Oral Communication
- 82-338 Mandarin Chinese for Oral Communication
- 82-432 Popular Culture in China
- 82-439 Modern China Through Literature Var.
- 82-440 Studies in Chinese Literature & Culture
- 82-443 Topics in Contemporary Culture of China
- 82-444 Studies in Chinese Traditions *
- 82-456 Introduction to Classical Chinese
- 82-531/532 Special Topics Chinese

**Spring**
- 82-331 Advanced Chinese I
- 82-332 Advanced Chinese II
- 82-333 Introduction to Chinese Language and Culture
- 82-334 Readings in Chinese
- 82-337 Mandarin Chinese for Oral Communication
- 82-338 Mandarin Chinese for Oral Communication
- 82-432 Popular Culture in China
- 82-439 Modern China Through Literature Var.
- 82-440 Studies in Chinese Literature & Culture
- 82-443 Topics in Contemporary Culture of China
- 82-444 Studies in Chinese Traditions *
- 82-456 Introduction to Classical Chinese
- 82-531/532 Special Topics Chinese

**Senior Year**

**Fall**
- 82-334 Readings in Chinese
- 82-337 Mandarin Chinese for Oral Communication
- 82-338 Mandarin Chinese for Oral Communication
- 82-432 Popular Culture in China
- 82-439 Modern China Through Literature Var.
- 82-440 Studies in Chinese Literature & Culture
- 82-443 Topics in Contemporary Culture of China
- 82-444 Studies in Chinese Traditions *
- 82-456 Introduction to Classical Chinese
- 82-531/532 Special Topics Chinese

**Spring**
- 82-334 Readings in Chinese
- 82-337 Mandarin Chinese for Oral Communication
- 82-338 Mandarin Chinese for Oral Communication
- 82-432 Popular Culture in China
- 82-439 Modern China Through Literature Var.
- 82-440 Studies in Chinese Literature & Culture
- 82-443 Topics in Contemporary Culture of China
- 82-444 Studies in Chinese Traditions *
- 82-456 Introduction to Classical Chinese
- 82-531/532 Special Topics Chinese

This is presented as a two-year (junior-senior) plan for completing major requirements. It shows that this program can be completed in as few as two years, not that it must be. Students should consult their advisor when planning their program.

### The Major in French and Francophone Studies 93 Units

Students may enter their major and begin major course requirements when they have met the prerequisites described below. Should they desire, students should also be able to complete an additional major or minor.

**Prerequisites** 0-42 units

Intermediate level proficiency in French. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in French and Francophone Studies 27 units

**Fall**
- 82-303 French Language
- 82-304 The Francophone World
- 82-305 French in its Social Contexts

**Spring**
- 82-303 French Language
- 82-304 The Francophone World
- 82-305 French in its Social Contexts

2. Core Courses in Modern Languages 12 units

**Fall**
- 82-281 Tutoring for Community Outreach
- 82-282 Community Service Learning
- 82-358 Literacies Across Language and Culture
- 82-383 Second Language Acquisition: Theories and Research
- 82-388 Understanding Second Language Fluency
- 82-480 Social and Cognitive Aspects of Bilingualism

**Spring**
- 82-303 French Language
- 82-304 The Francophone World
- 82-305 French in its Social Contexts

3. French and Francophone Studies Interdisciplinary Electives Complete 45 units from List A and 9 units from List B, or 54 units from List A.
List A. French and Francophone Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-404 Francophone Realities: Africa * 9</td>
</tr>
<tr>
<td>82-415/416 Topics in French and Francophone Studies * 9</td>
</tr>
<tr>
<td>82-501/502 Special Topics: French Var.</td>
</tr>
<tr>
<td>82-505 Undergraduate Internship -1</td>
</tr>
</tbody>
</table>

* Students may repeat with new topics.

List B. Interdisciplinary Electives

From possibilities such as but not limited to the following, students should consult with the Major Advisor to identify an interdisciplinary elective to complement their program.

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-338 European Cities in the XIX Century: Planning, Architecture, Preservation 9</td>
</tr>
<tr>
<td>48-340 Modern Architecture and Theory 1900-1945 9</td>
</tr>
<tr>
<td>48-341 History of Architectural Theory 9</td>
</tr>
<tr>
<td>48-448 History of Sustainable Architecture 9</td>
</tr>
</tbody>
</table>

English

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-239 Introduction to Film Studies 9</td>
</tr>
<tr>
<td>76-318 Communicating in the Global Marketplace 9</td>
</tr>
<tr>
<td>76-385 Introduction to Discourse Analysis 9</td>
</tr>
<tr>
<td>76-386 Language &amp; Culture 9</td>
</tr>
<tr>
<td>76-387 Narrative &amp; Argument 9</td>
</tr>
</tbody>
</table>

History

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-202 Flesh and Spirit: Early Modern Europe, 1400-1750 9</td>
</tr>
<tr>
<td>79-205 20th Century Europe 9</td>
</tr>
<tr>
<td>79-207 Development of European Culture 9</td>
</tr>
<tr>
<td>79-220 Caribbean: Cultures and Histories 9</td>
</tr>
<tr>
<td>79-227 Introduction to African History 1780-1994 9</td>
</tr>
<tr>
<td>79-258 French History: From the Revolution to De Gaulle 9</td>
</tr>
<tr>
<td>79-275 Introduction to Global Studies 9</td>
</tr>
<tr>
<td>79-350 Early Christianity 9</td>
</tr>
<tr>
<td>79-385 The Making of the African Diaspora 9</td>
</tr>
<tr>
<td>79-386 Entrepreneurs in Africa, Past, Present and Future 9</td>
</tr>
<tr>
<td>79-396 Music and Society in 19th and 20th Century Europe and the U.S. 9</td>
</tr>
</tbody>
</table>

Modern Languages

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-280 Learning About Language Learning 9</td>
</tr>
<tr>
<td>82-281 Tutoring for Community Outreach Var.</td>
</tr>
<tr>
<td>82-358 Literacies Across Language and Culture 9</td>
</tr>
<tr>
<td>82-380 Independent Study in Second Language Acquisition 9</td>
</tr>
<tr>
<td>82-383 Second Language Acquisition: Theories and Research 9</td>
</tr>
<tr>
<td>82-384 Language and Culture: Language in its Social Context 9</td>
</tr>
<tr>
<td>82-387 The Film Festival 9</td>
</tr>
<tr>
<td>82-388 Understanding Second Language Fluency 9</td>
</tr>
<tr>
<td>82-480 Social and Cognitive Aspects of Bilingualism 9</td>
</tr>
<tr>
<td>82-484 Language Assessment 9</td>
</tr>
<tr>
<td>82-487 Writing in a Second Language 9</td>
</tr>
</tbody>
</table>

Music

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-173 Survey of Western Music History 9</td>
</tr>
<tr>
<td>57-306 World Music 6</td>
</tr>
<tr>
<td>57-441 Analysis of 19th Century Music 9</td>
</tr>
</tbody>
</table>

Philosophy

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-180 Nature of Language 9</td>
</tr>
<tr>
<td>80-280 Linguistic Analysis 9</td>
</tr>
<tr>
<td>80-281 Language and Thought 9</td>
</tr>
<tr>
<td>80-380 Philosophy of Language 9</td>
</tr>
</tbody>
</table>

Psychology

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-375 Crosscultural Psychology 9</td>
</tr>
<tr>
<td>85-421 Language and Thought 9</td>
</tr>
</tbody>
</table>

New courses will be added as appropriate.

4. Oral Proficiency Interview

Complete an oral proficiency interview with a faculty member in French. This exam should be taken by the end of the first semester of the senior year.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

French and Francophone Studies (B.A.)

Sample Curriculum

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-303 French Culture Fall * 9</td>
</tr>
<tr>
<td>82-304 The Francophone World Spring 9</td>
</tr>
<tr>
<td>82-280 Learning About Language Learning Fall * 9</td>
</tr>
<tr>
<td>82-580 Senior Seminar 3</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. It shows that this program can be completed in as few as two years, not that it must be. Students should consult their advisor when planning their program.

The Major in German Studies 93 units

Students may enter their major and begin major course requirements when they have met the prerequisites described below. Should they desire, students should also be able to complete an additional major or minor.

Prerequisites 0-42 units

Intermediate level proficiency in German. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in German Studies 27 units

Complete all three courses.

B2-320 Contemporary Society in German, Austria and Switzerland 9
B2-323 Germany, Austria and Switzerland in the 20th Century 9
B2-327 The Emergence of the German Speaking World 9

* A 400-level course may be substituted with an advisor’s approval.

2. Core Courses in Modern Languages 12 units

Complete one 9-unit course* plus the 3-unit Senior Seminar 82-580

B2-280 Learning About Language Learning 9
B2-281 Tutoring for Community Outreach Var.
B2-282 Community Service Learning -1
B2-358 Literacies Across Language and Culture 9
B2-383 Second Language Acquisition: Theories and Research 9
B2-384 Understanding Second Language Fluency 9
B2-480 Social and Cognitive Aspects of Bilingualism 9
B2-580 Senior Seminar in Modern Languages 3

* In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in German or from another department. Examples: 80-180 Nature of Language, 85-421 Language and Thought.

3. German Studies and Interdisciplinary Electives 54 units

Complete 45 units from List A and 9 units from List B or 36 units from List A and 18 units from List B.

List A: German Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-420 German Classical Literature 9</td>
</tr>
<tr>
<td>82-421 German Literature of the Nineteenth Century 9</td>
</tr>
<tr>
<td>82-422 German Literature of the Early Twentieth Century 9</td>
</tr>
<tr>
<td>82-425/426 Topics in German Literature and Culture * 9</td>
</tr>
<tr>
<td>82-427 Nazi and Resistance Culture 9</td>
</tr>
<tr>
<td>82-428 History of German Film Var.</td>
</tr>
<tr>
<td>82-429 German Reading and Translation Workshop: Undergraduate 9</td>
</tr>
<tr>
<td>82-521/522 Independent Study Var.</td>
</tr>
</tbody>
</table>

* Students may repeat with new topics.

List B: Interdisciplinary Electives

The student may complete part of the course work in German (readings and written papers) with agreement of instructor.

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-239 Introduction to Film Studies 9</td>
</tr>
<tr>
<td>76-386 Language &amp; Culture 9</td>
</tr>
<tr>
<td>76-387 Narrative &amp; Argument 9</td>
</tr>
<tr>
<td>76-483 Corpus Analysis in Rhetoric 9</td>
</tr>
<tr>
<td>History</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>79-205</td>
</tr>
<tr>
<td>79-208</td>
</tr>
<tr>
<td>79-256</td>
</tr>
<tr>
<td>79-257</td>
</tr>
<tr>
<td>79-349</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modern Languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-281 Learning About Language Learning</td>
</tr>
<tr>
<td>82-281 Tutoring for Community Outreach</td>
</tr>
<tr>
<td>82-358 Literacies Across Language and Culture</td>
</tr>
<tr>
<td>82-383 Second Language Acquisition: Theories and Research</td>
</tr>
<tr>
<td>82-388 Understanding Second Language Fluency</td>
</tr>
<tr>
<td>82-480 Social and Cognitive Aspects of Bilingualism</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Music</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-306 World Music</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Philosophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-136 Social Structure, Public Policy &amp; Ethics</td>
</tr>
<tr>
<td>80-180 Nature of Language</td>
</tr>
<tr>
<td>80-251 Modern Philosophy</td>
</tr>
<tr>
<td>80-253 Continental Philosophy</td>
</tr>
<tr>
<td>80-256 Modern Moral Philosophy</td>
</tr>
<tr>
<td>80-275 Metaphysics</td>
</tr>
<tr>
<td>80-280 Linguistic Analysis</td>
</tr>
<tr>
<td>80-380 Philosophy of Language</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Psychology</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-375 Crosscultural Psychology</td>
</tr>
<tr>
<td>85-421 Language and Thought</td>
</tr>
</tbody>
</table>

Additional courses from other departments may be added to list as information becomes available.

4. Oral Proficiency Interview

Complete an oral proficiency interview with a faculty member in German. This exam should be taken by the end of the first semester of the senior year.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

German Studies (B.A.) Sample Curriculum

<table>
<thead>
<tr>
<th>Junior Year Fall</th>
<th>Senior Year Fall</th>
<th>Senior Year Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-320 Contemporary Society in German, Austria and Switzerland</td>
<td>82-327 The Emergence of the German Speaking World</td>
<td>82-383 Understanding Second Language Fluency</td>
</tr>
<tr>
<td>German Elective From List A</td>
<td>German Elective From List A</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
</tr>
<tr>
<td>82-280 Learning About Language Learning</td>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Required Elective From List A or List B</td>
<td>Elective</td>
</tr>
<tr>
<td>82-580 Senior Seminar in Modern Languages</td>
<td>82-580 Senior Seminar in Modern Languages</td>
<td>82-580 Senior Seminar in Modern Languages</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. It shows that this program can be completed in as few as two years, not that it must be. Students should consult their advisor when planning their program.

The Major in Hispanic Studies 93 units

Students may enter their major and begin major course requirements when they have met the prerequisites described below. Should they desire, students should also be able to complete an additional major or minor.

Prerequisites 0-42 units

Intermediate level proficiency in Spanish. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in Hispanic Studies 27 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-342</td>
<td>Spain: Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-343</td>
<td>Latin America: Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-344</td>
<td>U.S. Latinos: Language and Culture</td>
<td>9</td>
</tr>
</tbody>
</table>

Complete required course.

2. Core Courses in Modern Languages 12 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-280</td>
<td>Learning About Language Learning</td>
<td>9</td>
</tr>
<tr>
<td>82-281</td>
<td>Tutoring for Community Outreach</td>
<td>Var</td>
</tr>
<tr>
<td>82-282</td>
<td>Community Service Learning</td>
<td>-1</td>
</tr>
<tr>
<td>82-358</td>
<td>Literacies Across Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-383</td>
<td>Second Language Acquisition: Theories and Research</td>
<td>9</td>
</tr>
<tr>
<td>82-388</td>
<td>Understanding Second Language Fluency</td>
<td>9</td>
</tr>
<tr>
<td>82-480</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
<td>9</td>
</tr>
</tbody>
</table>

3. Hispanic Studies and Interdisciplinary Electives 54 units

Complete 45 units from List A and 9 units from List B, or 54 units from List A.

List A: Hispanic Studies Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-441</td>
<td>Studies in Peninsular Literature and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-442</td>
<td>Analysis of Spoken Spanish</td>
<td>9</td>
</tr>
<tr>
<td>82-443</td>
<td>Spanish Reading and Translation Workshop</td>
<td>9</td>
</tr>
<tr>
<td>82-444</td>
<td>The Structure of Spanish</td>
<td>9</td>
</tr>
<tr>
<td>82-445</td>
<td>U.S. Latino Literature</td>
<td>9</td>
</tr>
<tr>
<td>82-446</td>
<td>Political Drama of Spain</td>
<td>9</td>
</tr>
<tr>
<td>82-451</td>
<td>Studies in Latin American Literature and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-455</td>
<td>The Hispanic Caribbean: Rhythm, Reason and Song</td>
<td>9</td>
</tr>
<tr>
<td>82-456</td>
<td>Topics in Hispanic Studies</td>
<td>9</td>
</tr>
<tr>
<td>82-457</td>
<td>Contemporary Latin American Texts: Revision, Rewriting and Representation</td>
<td>9</td>
</tr>
<tr>
<td>82-506</td>
<td>Hispanic Studies Internship</td>
<td>-1</td>
</tr>
<tr>
<td>82-541/542</td>
<td>Special Topics: Hispanic Studies</td>
<td>Var</td>
</tr>
</tbody>
</table>

List B: Interdisciplinary Electives

From possibilities such as but not limited to the following, students should consult with the Major Advisor to identify an interdisciplinary elective to complement their program.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-239</td>
<td>Introduction to Film Studies</td>
<td>9</td>
</tr>
<tr>
<td>76-386</td>
<td>Language &amp; Culture</td>
<td>9</td>
</tr>
<tr>
<td>76-387</td>
<td>Narrative &amp; Argument</td>
<td>9</td>
</tr>
<tr>
<td>76-483</td>
<td>Corpus Analysis in Rhetoric</td>
<td>9</td>
</tr>
</tbody>
</table>

List C: European Studies

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-208</td>
<td>Europe’s Two Revolutions: Dynamics of Change in the 19th Century</td>
<td>9</td>
</tr>
<tr>
<td>79-220</td>
<td>Caribbean: Cultures and Histories</td>
<td>9</td>
</tr>
<tr>
<td>79-221</td>
<td>Development and Democracy in Latin America</td>
<td>9</td>
</tr>
<tr>
<td>79-325</td>
<td>Art and Religion</td>
<td>9</td>
</tr>
</tbody>
</table>

List D: Modern Languages

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-280</td>
<td>Learning About Language Learning</td>
<td>9</td>
</tr>
<tr>
<td>82-281</td>
<td>Tutoring for Community Outreach</td>
<td>Var</td>
</tr>
<tr>
<td>82-358</td>
<td>Literacies Across Language and Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-383</td>
<td>Second Language Acquisition: Theories and Research</td>
<td>9</td>
</tr>
<tr>
<td>82-388</td>
<td>Understanding Second Language Fluency</td>
<td>9</td>
</tr>
<tr>
<td>82-480</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
<td>9</td>
</tr>
</tbody>
</table>

Music

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-306</td>
<td>World Music</td>
<td>6</td>
</tr>
</tbody>
</table>

Philosophy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-180</td>
<td>Nature of Language</td>
<td>9</td>
</tr>
<tr>
<td>80-280</td>
<td>Linguistic Analysis</td>
<td>9</td>
</tr>
<tr>
<td>80-380</td>
<td>Philosophy of Language</td>
<td>9</td>
</tr>
</tbody>
</table>

Psychology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-375</td>
<td>Crosscultural Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-421</td>
<td>Language and Thought</td>
<td>9</td>
</tr>
</tbody>
</table>
4. Oral Proficiency Interview
Complete an oral proficiency interview with a faculty member in Spanish. This exam should be taken by the end of the first semester of the senior year.

Study Abroad
A semester or year of study abroad or internship is strongly recommended.

Hispanic Studies (B.A.)
Sample Curriculum

Junior Year
Fall
82-342: Spain: Language and Culture
82-345: Introduction to Hispanic Literary and Cultural Studies
82-343: Latin America: Language and Culture
82-280: Learning About Language Learning
82-272: Intermediate Japanese II
82-273: Introduction to Japanese Language and Culture
82-271: Advanced Japanese I
82-278: Japanese Literature in Translation
82-388: Understanding Second Language Fluency
82-380: Social and Cognitive Aspects of Bilingualism
82-380: Senior Seminar in Modern Languages

Spring
82-473: Topics in Japanese Studies
82-476: Japanese Discourse Analysis
82-571/572: Special Topics: Japanese

Senior Year
Fall
82-284: Spanish Elective From List A
82-286: Spanish Elective From List A
82-281: Tutoring for Community Outreach
82-288: Advanced Japanese II
82-282: Learning About Language Learning
82-283: Second Language Acquisition: Theories and Research
82-284: Understanding Second Language Fluency
82-480: Social and Cognitive Aspects of Bilingualism

Spring
82-285: Elective
82-287: Elective
82-289: Elective
82-290: Elective
82-291: Elective
82-292: Elective
82-293: Elective
82-294: Elective
82-295: Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. It shows that this program can be completed in as few as two years, not that it must be. Students should consult their advisor when planning their program.

The Major in Japanese Studies 102-105 units

Students may enter their major and begin major course requirements when they have met the prerequisites described below. Should they desire, students should also be able to complete an additional major or minor.

Prerequisites 0-36 units

Low-intermediate level proficiency in Japanese. This is equivalent to the completion of three courses (two at the 100-level and one at the 200-level) or exemption based on internal placement test scores.

1. Core Courses in Japanese Studies 27-39 units*

Complete all four courses.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-272</td>
<td>Intermediate Japanese II</td>
</tr>
<tr>
<td>82-273</td>
<td>Introduction to Japanese Language and Culture</td>
</tr>
<tr>
<td>82-271</td>
<td>Advanced Japanese I</td>
</tr>
<tr>
<td>82-278</td>
<td>Japanese Literature in Translation</td>
</tr>
<tr>
<td>82-288</td>
<td>Understanding Second Language Fluency</td>
</tr>
<tr>
<td>82-380</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
</tr>
<tr>
<td>82-380</td>
<td>Senior Seminar in Modern Languages</td>
</tr>
</tbody>
</table>

2. Core Courses in Modern Languages 12 units

Complete one 9 unit course plus the Senior Seminar

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-280</td>
<td>Learning About Language Learning</td>
</tr>
<tr>
<td>82-281</td>
<td>Tutoring for Community Outreach</td>
</tr>
<tr>
<td>82-282</td>
<td>Community Service Learning</td>
</tr>
<tr>
<td>82-358</td>
<td>Literacies Across Language and Culture</td>
</tr>
<tr>
<td>82-374</td>
<td>Technical Japanese</td>
</tr>
<tr>
<td>82-480</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
</tr>
<tr>
<td>83-580</td>
<td>Senior Seminar in Modern Languages</td>
</tr>
</tbody>
</table>

3. Core Course(s) in History* (minimum) 9 units

Complete one of the following History courses in consultation with the Major Advisor and the designated History or Modern Languages professor.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-261</td>
<td>Chinese Culture and Society</td>
</tr>
<tr>
<td>79-275</td>
<td>Introduction to Global Studies</td>
</tr>
<tr>
<td>79-280</td>
<td>Experiencing Globalization</td>
</tr>
<tr>
<td>79-310</td>
<td>Religions of China</td>
</tr>
<tr>
<td>79-360</td>
<td>Historical Evidence and Interpretation</td>
</tr>
</tbody>
</table>

* Majors are strongly encouraged to complete at least one more History course focusing on Japanese history in fulfillment of the major requirements. This list will evolve according to the current offerings of the Departments of History and Modern Languages.

4. Japanese Studies and Interdisciplinary Electives (minimum) 45 units

Complete five courses from List A or a minimum of three courses from List A and one or two courses from List B in consultation with the Major Advisor.

List A: Japanese Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-473/474</td>
<td>Topics in Japanese Studies</td>
</tr>
<tr>
<td>82-476</td>
<td>Japanese Discourse Analysis</td>
</tr>
<tr>
<td>82-571/572</td>
<td>Special Topics: Japanese</td>
</tr>
</tbody>
</table>

* Students may repeat with new topics.

List B: Interdisciplinary Electives

Electives should be chosen in consultation with the Major Advisor.

5. Oral Proficiency Interview
Complete an oral proficiency interview with a faculty member in Japanese. This exam should be taken by the end of the first semester of the senior year.

Study Abroad
A semester or year of study abroad or internship is strongly recommended.

Japanese Studies (B.A.) Sample Curriculum

Junior Year
Fall
82-273: Introduction to Japanese Language and Culture
82-280: Learning About Language Learning
82-281: Tutoring for Community Outreach
82-282: Community Service Learning
82-358: Literacies Across Language and Culture
82-374: Technical Japanese
82-388: Understanding Second Language Fluency
82-480: Social and Cognitive Aspects of Bilingualism

Spring
82-473: Topics in Japanese Studies
82-476: Japanese Discourse Analysis
82-571/572: Special Topics: Japanese

Senior Year
Fall
82-273: Core History Course
82-274: Advanced Japanese I
82-280: Learning About Language Learning
82-281: Tutoring for Community Outreach
82-282: Community Service Learning
82-358: Literacies Across Language and Culture
82-374: Technical Japanese
82-388: Understanding Second Language Fluency
82-480: Social and Cognitive Aspects of Bilingualism

Spring
82-473: Topics in Japanese Studies
82-476: Japanese Discourse Analysis
82-571/572: Special Topics: Japanese

* Majors are strongly encouraged to complete at least one more History course focusing on Japanese history in fulfillment of the major requirements. This list will evolve according to the current offerings of the Departments of History and Modern Languages.
This is presented as a two-year (junior-senior) plan for completing major requirements. It shows that this program can be completed in as few as two years, not that it must be. Students should consult their advisor when planning their program.

The Major in Russian Studies

Faculty Advisor: Charlene Castellano, Department of Modern Languages
Main Office: Baker Hall 160

The relationship between Russia and the West was central to the history of the entire twentieth century, and it continues in the twenty-first to influence politics throughout the globe. The rise in fascism, World War II, the Cold War, revolutions in Cuba, Korea, China, and Vietnam, and decolonization struggles in Africa cannot be understood apart from Russian influence. The current wars in the Middle East are no exception. The study of Russia is thus central to our understanding of the present world order and international relations. The disintegration of the USSR, the emergence of more democratic forms of government, and the development of new “free market” economies have led not only to greater openness and stronger ties with the West, but also to a host of emerging questions in the areas of business, science, technology, national defense, and international security. The end of the Cold War has allowed for exploration of new issues in fascinating ways that were formerly forbidden. The proliferation of exchange programs, the increased accessibility of libraries, archives, and information, and the development of a free press all open untold and exciting possibilities and opportunities for students and scholars. Young, talented people with a broadly-based knowledge of Russian history, language, and culture are needed to fill jobs in international law, education, diplomacy, business, journalism, and computing, as well as in economic, scientific, and technical consulting. The Russian Studies Program aims to give students a solid background in the fields of Russian history, language, culture, and politics, by offering a major and minor specialization to interested students.

Russian Studies, a B.A. Program, is jointly offered by the Departments of History and Modern Languages in the College of Humanities and Social Sciences. It is designed for students from all the Carnegie Mellon undergraduate colleges. It may be taken as either a primary major, additional major, or minor.

Russian Studies Major

93 - 96 units

The History Curriculum

27 units

For majors, there is a three-course History requirement comprised of one required course and two courses selected from a list of electives.

1. Core Course(s) in History

9 units

Complete one course.

79-265 Russian History: From the First to the Last Tsar
9

79-266 Russian History: From Communism to Capitalism
9

* Both courses are recommended.

2. Required Electives in History

18 units

Complete two courses. (Substitutions by advisor’s permission)

79-267 The Soviet Union in World War II: Military, Political and Social History
9

79-341 The Cold War in Documents and Film
9

The Language and Culture Curriculum

51 units

Complete the two prerequisite courses, two intermediate courses, and one advanced course.

3. Prerequisite Courses in Modern Languages

24 units

82-191 Elementary Russian I
12

(or demonstrated equivalent)

82-192 Elementary Russian II
12

(or demonstrated equivalent)

4. Core Courses in Modern Languages

27 units

82-291 Intermediate Russian
9

82-292 Intermediate Russian II
9

82-399 Special Topics Russian
1

Should a student enter the Russian Studies Program with a demonstrated language proficiency at any of these “Intermediate” or “Advanced” levels, the required total of 27 units is reached by selecting from among the advanced language options appearing below in the list of “Required Electives.” Advanced language options include Special Topics: Russian, a repeatable course, as well as subject-oriented language supplements to existing courses (taught in English) in a variety of fields. Thus students can add a language supplement (3 units) to selected 9-unit electives, earning a total of 12 units for the language-supplemented course.

5. Required Electives

18 units

Complete two courses.

History

79-205 20th Century Europe
9

79-231 American Foreign Policy 1945-Present
9

79-265 Russian History: From the First to the Last Tsar
9

79-266 Russian History: From Communism to Capitalism
9

79-267 The Soviet Union in World War II: Military, Political and Social History
9

79-322 Family and Gender in Russian History
9

Modern Languages

82-296 A Century of Russian Film
9

82-396 The Faust Legend at Home and Abroad
Var.

82-397 Russia’s Demons
Var.

82-399 Special Topics Russian
Var.

82-491 Literature, Politics and Film in Russia & East Europe Today
9

82-492 The Historical Imagination in Nineteenth-Century Russian Literature
Var.

New courses will be added as appropriate.

6. Required Independent Research

3-6 units

Complete one course.

82-599 Russian Studies Thesis
Var.

In the senior year, majors are required to undertake an independent research or translation project in which their language skills are applied to Russian-language materials. This project, which earns 3 to 6 units, is conducted in connection with an existing course in Russian history, language, literature or politics. The student works closely with the professor to select a topic requiring the use of Russian sources suitable to the student’s proficiency level. For example, students may choose to prepare a translation of a little-known piece of Russian literature or a debate from a nineteenth-century journal, to compare Soviet and Western newspaper coverage of the Cuban missile crisis, to research Russian opinion of American race relations, or to read and evaluate the reviews of a popular Russian novel.

7. Oral Proficiency Interview

Complete an oral proficiency interview with a faculty member in Russian. This exam should be taken by the end of the first semester of the senior year.

8. Study Abroad

Students in both the major and minor programs are encouraged to spend a semester or summer in Russia via an approved exchange program. Many exchange programs offer instruction in Russian language, history, literature, and culture, in internationally recognized universities. They also offer travel to ancient sites and cities, visits to museums, palaces, exhibitions, and monuments, and the opportunity to live with a Russian host family. Scholarship monies are frequently available.

Faculty Exchange Program

In 1993, the College of Humanities and Social Sciences initiated a faculty exchange program with the Russian State University of the Humanities (RGGU), one of the foremost universities in Russia, located in Moscow. Carnegie Mellon has hosted faculty members from RGGU specializing in history, language and philosophy. These professors have joined our College departments for a semester, offering unique courses and perspectives not generally available to our students. In the past, these Russian visitors have offered courses on the Russian Civil War as well as advanced language and literature courses. Several faculty members from Carnegie Mellon have visited Moscow, using the RGGU exchange to pursue archival research and collaborative projects. The exchange offers students an opportunity to study language from native speakers, gain exposure to different perspectives on history and politics, and gather firsthand knowledge about recent developments in Russia. In addition, the exchange can provide important contacts for students interested in pursuing careers abroad.

Russian Studies, B.A. Sample Curriculum

This sample curriculum assumes that all prerequisites for 82-291 are fulfilled prior to the junior year.

Junior Year

Fall

82-291 Intermediate Russian

Spring

82-292 Intermediate Russian II

Senior Year

Fall

82-399 Special Topics Russian

Spring

82-599 Russian Studies Thesis
**Modern Languages as an Additional Major**

H&SS students, as well as students from other colleges, may complete a major in Chinese Studies, French and Francophone Studies, German Studies, Hispanic Studies, Japanese Studies, and Russian Studies.

For the student who has chosen to major in another discipline, a minor in one of these languages is an asset which enhances almost any other field of study. The minor in Modern Languages permits students to acquire similar levels of communicative language proficiency as do students who major in the language but requires fewer courses in complementary areas.

Language-specific faculty advisors for these specializations are:

**Chinese Studies** - Gang Liu, Assistant Teaching Professor of Chinese Studies; Sue-mei Wu, Teaching Professor of Chinese Studies; and Tianxue Yao, Lecturer of Chinese Studies

**French & Francophone Studies** - Bonnie Youngs, Teaching Professor of French & Francophone Studies

**German Studies** - Christian Hallstein, Teaching Professor of German Studies

**Hispanic Studies** - Felipe Gomez, Associate Teaching Professor of Hispanic Studies and Therese Tardio, Associate Teaching Professor of Hispanic Studies

**Japanese Studies** - Yasufumi Iwasaki, Associate Teaching Professor of Japanese Studies and Yoshihiro Yasuhara, Assistant Teaching Professor of Japanese Studies

**European Studies** - Keny C. Dworkin (Hispanic Studies), Chris Hallstein (German), or Bonnie Youngs (French & Francophone Studies)

**Russian Studies** - Charlene Castellano, Teaching Professor of Russian Studies

* The minor in European Studies is an interdepartmental minor offered jointly with the Department of History. The European Studies minor is described in the H&SS Interdepartmental Minors section of the catalog.

**Curricula**

The minimum requirement for the minor in French and Francophone, German or Hispanic Studies is 54 units (not including any 100- or 200-level prerequisite work in the chosen language), as outlined below. The minimum requirement for the minor in Chinese or Japanese Studies is 54-60 units, depending on the student’s point of entry.

**The Minor in Chinese Studies**

**Prerequisites**

Intermediate level proficiency in Chinese. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. **Core Courses in Chinese Studies**

Complete four courses.

- 82-232 Intermediate Chinese I * 12
- 82-235 Intensive Intermediate Chinese * 12
- 82-331 Advanced Chinese I 9
- 82-332 Advanced Chinese II 9
- 82-333 Introduction to Chinese Language and Culture Var.

* 82-235 Intermediate-level Chinese course may be substituted for 82-232 Intermediate Chinese II.

**2. Chinese Studies and Interdisciplinary Electives**

List A: Chinese Studies Electives

Complete one or two courses after consultation with the Minor Advisor. Students may select another course in this category to substitute for the Interdisciplinary Elective.

- 82-334 Structure of Chinese 9
- 82-335 Readings in Chinese 9
- 82-337 Mandarin Chinese for Oral Communication 9
- 82-338 Mandarin Chinese for Oral Communication 9
- 82-432 Popular Culture in China 9
- 82-433 Topics in Contemporary Culture of China 9
- 82-434 Studies in Chinese Traditions 9
- 82-436 Introduction to Classical Chinese 9
- 82-439 Modern China Through Literature Var.

List B: Interdisciplinary Elective (minimum) 9 units

Complete one course. Students may select another course in this category to substitute for the Core Elective.

- 79-212 China and its Neighbors: Minorities, Conquerors and Tribute Bearers 9
- 79-261 Chinese Culture and Society 9
- 79-262 Modern China 9
- 79-308 18th Century China Through Literature 9
- 79-309 20th Century China Through Film 9
- 79-310 Religions of China 9
- 79-375 China’s Environmental Crisis 9
- 82-280 Learning About Language Learning 9
- 82-281 Tutoring for Community Outreach -1
- 82-358 Literacies Across Language and Culture 9
- 82-382 Second Language Acquisition: Theories and Research 9
- 82-388 Understanding Second Language Fluency 9
- 82-480 Social and Cognitive Aspects of Bilingualism 9

New courses will be added as appropriate.

**The Minor in French and Francophone Studies**

54 units

**Prerequisites**

Intermediate level proficiency in French. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. **Core Courses in French and Francophone Studies**

Complete three courses.

- 82-303 French Culture 9
- 82-304 The Francophone World 9
- 82-305 French in its Social Contexts 9

**2. French and Francophone Studies and Interdisciplinary Electives**

27 units

Complete 27 units from List A or 18 units from List A and 9 units from List B, with advisor’s approval.

**List A: French Studies Electives**

- 82-401 French Popular Song 9
- 82-404 Francophone Realities: Africa 9
- 82-407 The Arts in Society Var.
### List A: German Studies Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-415/416</td>
<td>Topics in French and Francophone Studies</td>
<td>9</td>
</tr>
<tr>
<td>82-501/502</td>
<td>Special Topics: French</td>
<td>Var.</td>
</tr>
<tr>
<td>82-505</td>
<td>Undergraduate Internship</td>
<td>Var.</td>
</tr>
</tbody>
</table>

* Students may repeat with new topics.

### List B: Interdisciplinary Electives

**Architecture**
- 48-340 Modern Architecture and Theory 1900-1945
- 48-341 History of Architectural Theory
- 48-448 History of Sustainable Architecture

**English**
- 76-385 Introduction to Discourse Analysis
- 76-386 Language & Culture
- 76-387 Narrative & Argument

**History**
- 79-202 Flex and Spirit: Early Modern Europe, 1400-1750
- 79-205 20th Century Europe
- 79-207 Development of European Culture
- 79-220 Caribbean: Cultures and Histories
- 79-227 Introduction to African History, 1780-1994
- 79-258 French History: From the Revolution to De Gaulle
- 79-275 Introduction to Global Studies
- 79-350 Early Christianity
- 79-386 Entrepreneurs in Africa, Past, Present and Future
- 79-396 Music and Society in 19th and 20th Century Europe and the U.S.

**Modern Languages**
- 82-281 Tutoring for Community Outreach
- 82-358 Literacies Across Language and Culture
- 82-380 Independent Study in Second Language Acquisition
- 82-383 Second Language Acquisition: Theories and Research
- 82-384 Language and Culture: Language in its Social Context
- 82-387 The Film Festival
- 82-388 Understanding Second Language Fluency
- 82-480 Social and Cognitive Aspects of Bilingualism
- 82-484 Language Assessment
- 82-487 Writing in a Second Language

**Music**
- 57-173 Survey of Western Music History
- 57-306 World Music

**Philosophy**
- 80-180 Nature of Language
- 80-280 Linguistic Analysis
- 80-281 Language and Thought
- 80-380 Philosophy of Language

**Psychology**
- 85-375 Crosscultural Psychology
- 85-421 Language and Thought

**List A: Hispanic Studies Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-427</td>
<td>Nazi and Resistance Culture</td>
<td>9</td>
</tr>
<tr>
<td>82-428</td>
<td>History of German Film</td>
<td>Var.</td>
</tr>
<tr>
<td>82-429</td>
<td>German Reading and Translation Workshop: Undergraduate</td>
<td>9</td>
</tr>
<tr>
<td>82-521/522</td>
<td>Independent Study</td>
<td>Var.</td>
</tr>
</tbody>
</table>

### List B: Interdisciplinary Electives

**English**
- 76-239 Introduction to Film Studies
- 76-386 Language & Culture
- 76-387 Narrative & Argument
- 76-483 Corpus Analysis in Rhetoric

**History**
- 79-205 20th Century Europe
- 79-208 Europe’s Two Revolutions: Dynamics of Change in the 19th Century
- 79-256 20th Century Germany
- 79-257 Germany and the Second World War
- 79-349 The Holocaust in Historical Perspective

**Music**
- 57-306 World Music

**Philosophy**
- 80-136 Social Structure, Public Policy & Ethics
- 80-180 Nature of Language
- 80-251 Modern Philosophy
- 80-253 Continental Philosophy
- 80-256 Modern Moral Philosophy
- 80-275 Metaphysics
- 80-280 Linguistic Analysis
- 80-380 Philosophy of Language

**Psychology**
- 85-375 Crosscultural Psychology
- 85-421 Language and Thought

### The Minor in Hispanic Studies

**Prerequisites**

Intermediate level proficiency in Spanish. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. **Core Courses in Hispanic Studies**
   - Complete two courses.
   - 82-342 Spain: Language and Culture
   - 82-343 Latin America: Language and Culture
   - 82-344 U.S. Latinos: Language and Culture

2. **Hispanic Studies and Interdisciplinary Electives**
   - After consultation with the Minor Advisor, complete 3 courses (27 units) from List A or 2 courses (18 units) from List A and one course (9 units) from List B.

### List A: Hispanic Studies Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-320</td>
<td>Contemporary Society in Germany, Austria and Switzerland</td>
<td>9</td>
</tr>
<tr>
<td>82-323</td>
<td>Germany, Austria and Switzerland in the 20th Century</td>
<td>9</td>
</tr>
<tr>
<td>82-327</td>
<td>The Emergence of the German Speaking World</td>
<td>9</td>
</tr>
</tbody>
</table>

* A 400-level course may be substituted with an advisor’s approval.

### List B: Interdisciplinary Electives

1. **20th Century Europe**
   - 79-208 Europe’s Two Revolutions: Dynamics of Change in the 19th Century
   - 79-256 20th Century Germany
   - 79-257 Germany and the Second World War
   - 79-349 The Holocaust in Historical Perspective

2. **20th Century Germany**
   - 79-256 20th Century Germany

3. **The Holocaust in Historical Perspective**
   - 79-349 The Holocaust in Historical Perspective

### Additional courses from other departments may be added to list as information becomes available.

### The Minor in German Studies

**Prerequisites**

Intermediate level proficiency in German. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. **Core Courses in German Studies**
   - Complete three courses.
   - 82-320 Contemporary Society in German, Austria and Switzerland
   - 82-323 Germany, Austria and Switzerland in the 20th Century
   - 82-327 The Emergence of the German Speaking World

2. **German Studies & Interdisciplinary Electives**
   - Complete 27 units from List A (400 level German courses) or 18 units from List A and 9 units from List B, with advisors approval.

### List A: German Studies Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-420</td>
<td>German Classical Literature</td>
<td>9</td>
</tr>
<tr>
<td>82-421</td>
<td>German Literature of the Nineteenth Century</td>
<td>9</td>
</tr>
<tr>
<td>82-422</td>
<td>German Literature of the Early Twentieth Century</td>
<td>9</td>
</tr>
<tr>
<td>82-425/426</td>
<td>Topics in German Literature and Culture</td>
<td>9</td>
</tr>
</tbody>
</table>
The Minor in Russian Studies

Faculty Advisor: Charlene Castellano, Department of Modern Languages
Main Office: Baker Hall 160

The relationship between Russia and the West was central to the history of the entire twentieth century, and it continues in the twenty-first to influence politics throughout the globe. The rise in fascism, World War II, the Cold War, revolutions in Cuba, Korea, China, and Vietnam, and decolonization struggles in Africa cannot be understood apart from Russian influence. The current wars in the Middle East are no exception. The study of Russia is thus central to our understanding of the present world order and international relations. The disintegration of the USSR, the emergence of more democratic forms of government, and the development of new “free market” economies have led not only to greater openness and stronger ties with the West, but also to a host of emerging questions in the areas of business, science, technology, national defense, and international security. The end of the Cold War has allowed for exploration of new issues in fascinating ways that were formerly forbidden. The proliferation of exchange programs, the increased accessibility of libraries, archives, and information, and the development of a free press all open untried and exciting possibilities and opportunities for students and scholars.

Young, talented people with a broadly-based knowledge of Russian history, language, and culture are needed to fill jobs in international law, education, diplomacy, business, journalism, and computing, as well as in economic, scientific, and technical consulting. The Russian Studies Program aims to give students a solid background in the fields of Russian history, language, culture and politics, by offering a major and minor specialization to interested students.

The Russian Studies minor is jointly offered by the Departments of History and Modern Languages in the College of Humanities and Social Sciences.

**Russian Studies Minor** 78 units

**The History Curriculum** 18 units

For minors, there is a two course History requirement comprised of one required course and one course selected from a list of electives. The intermediate-level History courses are generally taken in the sophomore and junior years. They provide a substantive overview of the major events and issues in Russian history and policy.

1. Core Course(s) in History 9 units

   Complete one course.
   79-265 Russian History: From the First to the Last Tsar 9
   79-266 Russian History: From Communism to Capitalism 9

   * Both courses are recommended.

2. Required Electives in History 9 units

   Complete one course (Substitutions by advisor’s permission).
   79-282 Europe and the World 9

**The Language and Culture Curriculum** 42 units

Complete the two prerequisite courses and two intermediate courses.

3. Prerequisite Courses in Modern Languages 24 units

   82-191 Elementary Russian I (or demonstrated equivalent) 12
   82-192 Elementary Russian II (or demonstrated equivalent) 12

4. Core Courses in Modern Languages 18 units

   82-291 Intermediate Russian 9
   82-292 Intermediate Russian II 9

New courses will be added as appropriate.
Should a student enter the Russian Studies Program with a demonstrated language proficiency at any of these “Intermediate” levels, the required total of 18 units is reached by selecting from among the advanced language options appearing below in the list of “Required Electives”. Advanced language options include “Advanced Russian I”, “Advanced Russian II” and “Special Topics: Russian”, as well as subject-oriented language supplements to existing courses (taught in English) in a variety of fields. Thus students can add a language supplement (3 units) to selected 9-unit electives, earning a total of 12 units for the language-supplemented course.

5. Required Electives 18 units

Complete two courses.

<table>
<thead>
<tr>
<th>History</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-205 20th Century Europe</td>
<td>9</td>
</tr>
<tr>
<td>79-231 American Foreign Policy 1945-Present</td>
<td>9</td>
</tr>
<tr>
<td>79-280 Experiencing Globalization</td>
<td>9</td>
</tr>
<tr>
<td>79-281 Introduction to Religion</td>
<td>9</td>
</tr>
<tr>
<td>79-282 Europe and the World</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modern Languages</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-392 Advanced Russian II</td>
<td>9</td>
</tr>
<tr>
<td>82-396 The Faust Legend at Home and Abroad</td>
<td>Var.</td>
</tr>
<tr>
<td>82-397 Russia’s Demons</td>
<td>Var.</td>
</tr>
<tr>
<td>82-399 Special Topics Russian</td>
<td>Var.</td>
</tr>
<tr>
<td>82-491 Literature, Politics and Film in Russia &amp; East Europe Today</td>
<td>Var.</td>
</tr>
<tr>
<td>82-492 The Historical Imagination in Nineteenth-Century Russian Literature</td>
<td>Var.</td>
</tr>
<tr>
<td>82-493 Joseph Brodsky in Context</td>
<td>9</td>
</tr>
</tbody>
</table>

New courses will be added as appropriate.

6. Study Abroad

Students in both the major and minor programs are encouraged to spend a semester or summer in Russia via an approved exchange program. Many exchange programs offer instruction in Russian language, history, literature, and culture, in internationally recognized universities. They also offer travel to ancient sites and cities, visits to museums, palaces, exhibitions, and monuments, and the opportunity to live with a Russian host family. Scholarship monies are frequently available.

Faculty

MARIANA ACHUGAR, Associate Professor of Spanish & Second Language Acquisition – Ph.D., University of California at Davis; Carnegie Mellon, 2003–.

STEPHEN BROCKMANN, Professor of German with courtesy appointments in English and History – Ph.D., University of Wisconsin Madison; Carnegie Mellon, 1993–.

CHARLENE CASTELLANO, Teaching Professor of Russian with a courtesy appointment in English – Ph.D., Cornell University; Carnegie Mellon, 1990–.

REMI (ADAM) VAN CUMPERNOLLE, Assistant Professor of French and Francophone Studies & Second Language Acquisition – Ph.D., Penn State; Carnegie Mellon, 2012–.

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PAUL HOPPER, Paul Mellon Distinguished Professor of the Humanities, Rhetoric and Linguistics with a courtesy appointment in Modern Languages – Ph.D., University of Texas; Carnegie Mellon, 1990–.

YASUFUMI IWASAKI, Associate Teaching Professor of Japanese – Ph.D., University of Illinois, Carnegie Mellon, 2005–.

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BONNIE L. YOUNGS, Teaching Professor of French – Ph.D., University of Pennsylvania; Carnegie Mellon, 1993–.

YUEMING YU, Teaching Professor of Chinese – Ed.D., University of Pittsburgh; Carnegie Mellon, 1992–.
Department of Philosophy

Richard Scheines, Department Head
Office: Baker Hall 135
http://www.hss.cmu.edu/philosophy/index.php

The Department of Philosophy was founded in 1985 and reflects the tradition of philosophy as a central discipline in the humanities. The department has achieved an international reputation through the acclaimed research of its members and its innovative educational programs, not only in traditional topics such as ethics, philosophy of mind, logic, and theory of knowledge, but in such contemporary and applied areas as automated theorem proving, machine learning, the foundations of statistics, causal discovery, forward learning theory, game and decision theory, conflict resolution, and business ethics.

Philosophy thrives through contact with other disciplines. Interdisciplinary work, a traditional strength of the Carnegie Mellon community, is vital to the department and is reflected in the courses we offer, many of which incorporate substantive material from a range of other disciplines. Some courses are actually team-taught with professors from other departments and schools around the university.

Our programs are designed to develop our students’ analytical sophistication and their practical and theoretical skills in specializations outside the department (see the sample curricula below). The department welcomes and, indeed, encourages minors and additional majors from other disciplines who are interested in reflecting on the foundation of their own subjects. The department offers two different undergraduate major programs, and jointly sponsors two interdepartmental majors: Ethics, History, and Public Policy (with the Department of History), and Linguistics (with English, Modern Languages, and Psychology):

- the B.A. or B.S. in Ethics, History, and Public Policy (interdisciplinary major with Department of History)
- the B.S. in Logic and Computation
- the B.A. in Philosophy
- the B.A. in Linguistics (interdisciplinary major with Departments of English, Modern Languages, and Psychology)

The major in Logic and Computation is perhaps the most non-traditional of the department’s majors. It offers students a firm background in computer science, together with a solid grounding in logic, philosophy, and mathematics. This reflects the department’s commitment to the use of formal, analytic methods in addressing philosophical issues. A flexible system of electives allows students to focus their efforts in any of a wide range of disciplines, from engineering to the fine arts. As a capstone to the program, students engage in original research in their senior year, and write a thesis under the direction of an advisor.

The department also sponsors four minor programs:

- the minor in Ethics
- the minor in Linguistics
- the minor in Logic and Computation
- the minor in Philosophy

Finally, the department offers two master’s programs directly extending the departmental majors. Both programs are coordinated with and build on the undergraduate programs, so that majors can complete the requirements for the master’s degree in one additional year:

- the M.S. in Logic and Computation
- the M.A. in Philosophy

Students who choose the appropriate specialized track in the Logic and Computation major (namely, sample 2 of the Curricula listed below) can be admitted to the M.S. program in Language and Information Technology offered by the School of Computer Science. To complete the discussion of departmental programs, it should be mentioned that the department sponsors as part of the Program in Pure and Applied Logic (offered jointly with the Departments of Computer Science and Mathematics) a Ph.D. in Logic, Computation, and Methodology.

The Major in Ethics, History, and Public Policy

Faculty Advisor: Jay Aronson
Office: Baker Hall 246B, 412/268-2887
Email: aronson@andrew.cmu.edu.

The B.A./B.S. in Ethics, History, and Public Policy is an interdepartmental major offered jointly by the Departments of History and Philosophy. It prepares students for leadership positions in law, public policy, ethics, and advocacy by providing them with a rigorous, interdisciplinary humanistic and social-scientific education. It also serves as an excellent springboard for graduate study in a wide variety of disciplines. The program focuses equally on the historical understanding of how modern-day problems have evolved, and the importance of developing clear criteria for ethical decision-making. The capstone project course provides students with the opportunity to engage with real-world public policy challenges using the methods, theories, and knowledge that they have gained through the major. Offered jointly by the departments of History and Philosophy, the B.A./B.S. in EHPP encourages specialization, internship experiences, and research in a wide range of policy areas.

Curriculum

Students graduating with a primary major in Ethics, History, and Public Policy may elect to receive either a Bachelor of Arts or a Bachelor of Science Degree (additional requirements apply; see below). Basic requirements include 123 units encompassing 9 units in Economics, 39 units in History, 36 units in Philosophy, 27 units of elective courses, and a 12-unit, senior capstone course. This program may also be taken as an additional (e.g., second) major.

I. Economics Requirement 9 units

Choose one of the following:

73-100 Principles of Economics 9
88-220 Policy Analysis I 9

II. History Core 39 units

Choose one 9-unit course from each category below:

Policy History (9 units)

79-300 History of American Public Policy 9

U.S. History (9 units)

79-240 The Development of American Culture 9
79-249 20th Century U.S. 9

Non-U.S. History (9 units)

79-205 20th Century Europe 9
79-207 Development of European Culture 9
79-220 Caribbean: Cultures and Histories 9
79-222 Between Revolutions: The Development of Modern Latin America 9
79-226 Introduction to African History: Earliest Times to 1780 9
79-227 Introduction to African History: 1780-1994 9
79-307 Religion and Politics in the Middle East 9
79-261 Chinese Culture and Society 9
79-265 Russian History: From the First to the Last Tsar 9
79-266 Russian History: From Communism to Capitalism 9

Historical Methods and Approaches (12 units)

79-360 Historical Evidence and Interpretation 12

III. Philosophy Core 36 units

Choose one 9-unit course from each category below. No more than 18 units at the 100 level may be counted toward this requirement.

Ethics (9 units)

80-130 Introduction to Ethics 9
80-230 Ethical Theory 9

Political Philosophy (9 units)

80-135 Introduction to Political Philosophy 9
80-235 Political Philosophy 9

Foundations of Social Science (9 units)

80-221 Philosophy of Social Science 9
80-321 Causation, Law, and Social Policy 9
80-337 Philosophy Politics & Economics 9

Applied Philosophy (9 units)

80-136 Social Structure, Public Policy & Ethics 9
80-241 Ethical Judgments in Professional Life 9
80-244 Environmental Ethics 9
80-245 Medical Ethics 9
80-247 Ethics and Global Economics 9
80-341 Computers, Society and Ethics 9
Courses from the EHPP History Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.

79-221 Development and Democracy in Latin America 9
79-231 American Foreign Policy 1945-Present 9
79-233 The United States and the Middle East since 1945 9
79-242 Topics in African American History: Reconstruction to the Present 9
79-267 The Soviet Union in World War II: Military, Political and Social History 9
79-288 Banana, Baseball, and Borders: A History of Latin America - US Relations 9
79-303 Pittsburgh and the Transformation of Modern Urban America 6
79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967 9
79-306 Delinquency, Crime, and Juvenile Justice: 1970s to the Present 9
79-320 Women, Politics, and Protest 9
79-331 Body Politic: Women and Health in America 9
79-333 Biology and Society: Evolution Animal Experimentation and Eugenics 9
79-334 Law, Ethics, and the Life Sciences 9
79-335 Drug Use and Drug Policy 9
79-338 Education and Social Reform 9
79-339 Juvenile Delinquency Through Film 6
79-342 Introduction to Science and Technology Studies 6
79-359 Sustainable Innovations: Ideas, Policies & Technologies to Make a Better Planet 9
79-368 Poverty, Charity, and Welfare 9
79-371 African American Urban History 9
79-374 American Environmental History: Critical Issues 9
79-381 Energy, Environment, Globalization in the Americas 9
79-383 Epidemic Disease and Public Health 9
79-389 Stalin and Stalinism 9

Philosophy

Courses from the EHPP Philosophy Core (above) may be taken as electives only if they are not being used to fulfill the core requirement. Double counting is not permitted.

80-305 Rational Choice 9
80-405 Game Theory 9
80-241 Ethical Judgments in Professional Life 9

80-256 Modern Moral Philosophy 9
80-341 Computers, Society and Ethics 9
80-344 Management, Environment, and Ethics 9

Social and Decision Sciences
88-104 Decision Processes in American Political Institutions 9
88-181 Topics in Law 1st Amendment 9
88-223 Decision Analysis and Decision Support Systems 9
88-343 Economics of Technological Change 9
88-345 Perspectives on Industrial Research and Development 9
88-347 Complex Technological Systems: Past, Present, and Future 9
88-371 Entrepreneurship, Regulation and Technological Change 9
88-387 Social Norms and Economics 9
88-423 Institutions, Entrepreneurship, and Innovation 9
88-444 Public Policy and Regulation 9

Additional Major

The B.A./B.S. in Ethics History and Public Policy may be scheduled as an additional major in consultation with the departments concerned.

Ethics, History, and Public Policy Sample Curriculum

Junior Year
Fall
Core requirement in History or Philosophy 9
Spring
Core requirement in History or Philosophy 9
Senior Year
Fall
Capstone Course 9
Spring
EHPP Elective Course 9

VI. Bachelor of Science Option

Students may elect to earn a Bachelor of Science rather than a Bachelor of Arts degree by completing two courses from the list below, as petitioning the Director of EHPP to accept equivalent courses as substitutions.

21-257 Models and Methods for Optimization 9
36-202 Students may take 36-202 OR 36-208 9
36-207 Probability and Statistics for Business Applications 9
36-208 Regression Analysis 9
36-303 Sampling, Survey and Society 9
36-309 Experimental Design for Behavioral and Social Sciences 9
80-305 Rational Choice 9
88-251 Empirical Research Methods 9
required to write a Senior Thesis in their final year. At least three courses (not including specific language courses) must be at the 300-level or higher. All courses counted towards the major must be taken for a letter grade and passed with a grade of “C” or above. For Dietrich College students, up to 2 of these courses may be counted also as satisfying the college’s general education requirements (as long as the double-counting maximum established by the college is not exceeded), with permission of the major director.

**Introductory course**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-180</td>
<td>Nature of Language</td>
<td>9</td>
</tr>
</tbody>
</table>

**Fundamental Skills**

Take **one** course from **each** of the following core subject areas:

- **Sounds**
  - 80-282 Phonetics and Phonology

- **Structure**
  - 80-280 Linguistic Analysis
  - 76-389 Rhetorical Grammar
  - 80-283 Syntax and Discourse

- **Meaning**
  - 80-381 Meaning in Language
  - 80-383 Language in Use
  - 76-385 Introduction to Discourse Analysis

**Breadth**

Take **one** course from **each** of the following breadth subject areas:

**Area 1: Language Learning and Language Cognition**

- 76-420 Process of Reading and Writing
- 82-280 Learning About Language Learning
- 82-383 Second Language Acquisition: Theories and Research
- 82-585 Topics in Second Language Acquisition
- 85-354 Infant Language Development
- 85-421 Language and Thought

**Area 2: Discourse, Society and Culture**

- 76-318 Communicating in the Global Marketplace
- 76-385 Introduction to Discourse Analysis
- 76-386 Language & Culture
- 82-273 Introduction to Japanese Language and Culture
- 82-305 French in its Social Contexts
- 82-313 Arabic Language and Culture I
- 82-312 Arabic Language and Culture II
- 82-333 Introduction to Chinese Language and Culture

**Electives**

Take **four** additional electives. These can be **additional courses from the Fundamental Skills courses or Breadth courses listed above, or any other course which is approved** by the Director as a linguistics elective. Listed below are the additional electives taught on a regular basis. **Additional appropriate courses** are offered irregularly or on a one-off basis. The Director will provide students with a list of possible electives each semester, and will assist students in selecting electives which are consistent with their goals and interests.

- 76-373 Topics in Rhetoric: Argument
- 76-378 Literary Educational Theory and Community Practice
- 76-451 Topics in Language Study
- 76-476 Rhetoric of Science
- 80-281 Language and Thought
- 80-380 Philosophy of Language
- 82-345 Introduction to Hispanic Literary and Cultural Studies
- 82-373 Structure of the Japanese Language
- 82-378 Japanese Conversation Analysis
- 82-388 Understanding Second Language Fluency
- 82-442 Analysis of Spoken Spanish
- 82-444 The Structure of Spanish
- 82-476 Japanese Discourse Analysis
- 82-480 Social and Cognitive Aspects of Bilingualism
- 82-488 Language Learning in a Study Abroad Context
- 80-382 Linguistics of Germanic Languages
- 11-411 Natural Language Processing
- 11-716 Graduate Seminar: Symbolic Processing
- 11-721 Grammars and Lexicons
- 11-722 Grammar Formalisms
- 11-761 Language and Statistics
- 11-762 Language and Statistics II
- 15-492 Special Topic: Speech Processing

**Language Requirement**

Students must successfully complete two semesters of consecutive language courses. (Note that students may not 'test out' of this requirement. However, language courses taken at other institutions or as part of a study abroad program will typically substitute for a semester of language study.)

**Senior Thesis [primary majors only]**

Primary majors must complete a senior thesis (a workload equivalent to a 12-unit course) during their senior year. Topics must be approved by an advisor, who will work with the student and guide the thesis project.

**Notes**

- Course numbers 82-305, 82-311, 32-312, 82-373, 82-378, 82-442, 82-444, 82-476 are taught in the language of analysis.

- Course number 82-345 topics vary; consult with Director.

All 11-xxx and 15-xxx courses have significant Computer Science prerequisites. Interested students should check with the course instructor before registering.

Language specific “Language and Culture” courses may be taken either as electives or towards the second breadth area.

However only one such course per language area may be counted towards the major.

**The Major in Logic and Computation**

Peter Spirtes, Director
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Email: ps7z@andrew.cmu.edu

The Logic and Computation curriculum takes advantage of the preparation provided by the H&SS General Education Program in mathematics, philosophy, psychology, and statistics. It is flexible in that it permits students to focus on any of a number of areas including (but not limited to):

- computer science;
- language and information technology;
- artificial intelligence and cognitive science;
- logic and the foundations of mathematics;
- methodology and philosophy of science.

Students in the program take a common core of courses in logic, methodology, and computer science, together with an associated seminar in their senior year. The individual focus is achieved by selecting a sequence of four advanced and closely related courses. It is in this area of focus (or specialization) that students write their senior thesis under the supervision of a faculty member. A number of sample curricula are presented below.

The resulting education in logic, analytic philosophy, mathematics, statistics, and computer science enables students to pursue professional careers or graduate study. The analytic and communication skills developed in the major support a wide range of career choices, including those among the fields of technology, business, and law. Fields of graduate study for which students are well prepared include, for example, computer science, cognitive science, philosophy, logic, and linguistics.

Students who are interested in pursuing this major, or who are pursuing it already, should take note of the Cognitive Science major in the Department of Psychology. That major is so closely related that it is not difficult to pursue it as an additional major, and it provides an intellectually exciting complement.

**Curriculum**

Logic and Computation is a B.S. degree. In their freshman and sophomore years, students are expected to take three courses that provide preparation in computer science, mathematics, and statistics: 15-112 Fundamentals of Programming and Computer Science, 21-127 Concepts of Mathematics, 36-201 Statistical Reasoning and Practice. 80-211 Logic and Mathematical Inquiry is part of the major’s Core Requirements, but should be taken no later than the spring of the sophomore year. This also applies to the computer science sequence 15-122 and 15-150.

**NOTE:** Students should complete the prerequisites before their junior year. It is strongly recommended that students take 80-211 Logic and Mathematical Inquiry no later than the spring of their sophomore year and, if possible, also 15-121 and 15-150/15-211. However, with suitable planning and advice from the program director, it is possible to complete the program in two years, beginning in the junior year.

The course requirements for the major consist of seven core courses (including one seminar) and four electives. The core courses provide comprehensive background in logic, computability, and analytic philosophy. 80-310 Formal Logic and 80-150 Nature of Reason must be taken no later than the fall of the junior year. Four advanced electives are chosen in the area of focus, and should support independent research towards fulfilling
the senior thesis requirement. In their senior year, students present and discuss their research in 80-511 Thesis Seminar.

Prerequisites 28 units
15-110 Principles of Computing 10
21-227 Concepts of Mathematics 20
36-201 Statistical Reasoning and Practice 9

Logic and Computation Core 69-71 units
80-150 Nature of Reason 9
80-211 Logic and Mathematical Inquiry 9
80-310 Formal Logic 9
80-311 Undecidability and Incompleteness 9
15-121 Introduction to Data Structures 10
15-150 Principles of Functional Programming 10
or 15-211 Fundamental Data Structures and Algorithms 9
80-511 Thesis Seminar 9

Logic and Computation Electives 36 units
Bearing in mind prerequisites, Logic and Computation majors must complete four advanced courses in areas that use logical and computational tools, such as philosophy, computer science, linguistics, mathematical logic, psychology, or statistics. The sequence of courses, mostly at the 300-level, must be selected in consultation with the program director.

Sample Curricula
Here are five samples of Logic and Computation curricula (beyond the core courses), each reflecting a different emphasis.

Sample 1. A student interested in Computer Science might take the following courses:
- 80-315 Modal Logic 9
- 80-413 Category Theory 9
- 15-312 Foundations of Programming Languages 12
- 15-317 Constructive Logic 9

Sample 2. A student interested in Language and Information Technology might take the following courses:
- 80-280 Linguistic Analysis 9
- 80-281 Language and Thought 9
- 80-381 Meaning in Language 9
- 80-580 Seminar on the Philosophy of Language 9

Sample 3. A student interested in Artificial Intelligence and Cognitive Science might take the following courses:
- 80-313 Philosophical Logic 9
- 80-314 Logic and Artificial Intelligence 9
- 80-315 Modal Logic 9
- 80-411 Proof Theory 9
- 80-412 Cognitive Modeling 9

Sample 4. A student interested in Logic and the Foundations of Mathematics might consider the following courses:
- 80-254 Analytic Philosophy 9
- 80-312 Philosophy of Mathematics 9
- 80-365 Ramsey 9
- 80-411 Proof Theory 9
- 80-413 Category Theory 9

Sample 5. A student interested in Methodology might consider the following courses:
- 80-220 Philosophy of Science 9
- 80-221 Philosophy of Social Science 9
- 80-321 Causation, Law, and Social Policy 9
- 36-309 Experimental Design for Behavioral and Social Sciences 9

Logic and Computation Degree 360 units

Logic and Computation as a Second Major
The Logic and Computation major is also suitable as a second major for students in H&SS or for students in other colleges within the university. Non-H&SS students interested in an additional major in Logic and Computation need to take only those courses in the H&SS General Education Program that are prerequisites to courses required in the major; all other H&SS General Education requirements are waived for these students. Depending on the student’s background, the requirements of the second major in Logic and Computation can be fulfilled with as few as five additional courses.

However, the department limits the courses that may be ‘double counted’; the core courses in the Philosophy department may not be double counted.

The M.S. Program in Logic and Computation
The Department of Philosophy also offers a graduate M.S. degree in Logic and Computation, which culminates with the writing of a master’s thesis. It is ordinarily a two-year program, but students in the Logic and Computation major are able to complete the additional requirements in one year. Interested students are invited to contact the department for further information and apply to the program in their senior year. Details can be found on the department’s homepage: http://hss.cmu.edu/philosophy/

The Major in Philosophy
Mara Harrell, Director
Office: Baker Hall 161G
Email: mharrell@andrew.cmu.edu

The Major in Philosophy is intended to be flexible and to facilitate double majors in other fields (including majors with a strong professional focus). It provides students with a broad humanities education and sharpens their analytical skills. We encourage, but do not require, students to choose a thematic concentration through their electives. Sample curricula emphasizing Pre-Law, Metaphysics and Epistemology, Ethics and Social Philosophy, and Philosophy of Mind are suggested below. However, alternative emphases can be proposed and approved by the Director. The Major in Philosophy is a B.A. degree.

Curriculum
In addition to the general education requirements for the student’s college, Philosophy primary majors and additional majors must complete 60-100 Introduction to Philosophy and nine Philosophy courses in the Areas listed below. The 80-100 requirement must be fulfilled before the first semester of the junior year. Only two of the remaining nine courses may be at the 100-level, and two of the nine courses must be at the 300-level or higher. All ten courses, if taken at CMU, must be taken for a letter grade and passed with a grade of "C" or above. Courses from other universities, as well as an 80-100 skills test, may be substituted with permission of the Director. For H&SS students, up to 4 of these courses may be counted also as satisfying the College’s General Education requirements, with permission of the Director. Students are to choose one course out of each of the Areas 1-4, two courses out of Area 5, and may freely select three courses in Area 6. As per the requirement of the College of H&SS, a student’s Freshman Seminar course may not count toward the fulfillment of the major requirements.

Introduction to Philosophy 9 units
80-100 Introduction to Philosophy 9

9 unitsArea 1: Values and Normative Theory
One of the following:
- 80-130 Introduction to Ethics 9
- 80-135 Introduction to Political Philosophy 9
- 80-136 Social Structure, Public Policy & Ethics 9
- 80-230 Ethical Theory 9
- 80-235 Political Philosophy 9
- 80-241 Ethical Judgments in Professional Life 9
- 80-243 Business Ethics 9
- 80-244 Environmental Ethics 9
- 80-245 Medical Ethics 9
- 80-247 Ethics and Global Economics 9
- 80-337 Philosophy Politics & Economics 9
- 80-341 Computers, Society and Ethics 9
- 80-344 Management, Environment, and Ethics 9
- 80-348 Health Development and Human Rights 9
- 80-447 Global Justice 9

Area 2: Philosophy of Mind/ Language/Metaphysics 9 units
One of the following:
- 80-180 Nature of Language 9
- 80-270 Philosophy of Mind 9
- 80-271 Philosophy and Psychology 9
- 80-275 Metaphysics 9
- 80-276 Philosophy of Religion 9
- 80-280 Linguistic Analysis 9
- 80-281 Language and Thought 9
- 80-380 Philosophy of Language 9
- 80-381 Meaning in Language 9
- 80-575 Seminar on Metaphysics -
- 80-580 Seminar on the Philosophy of Language 9

9 unitsArea 3: Logic/Philosophy of Mathematics

Reference: Dietrich College of Humanities and Social Sciences
One of the following:
- B0-110 Nature of Mathematical Reasoning 9
- B0-210 Logic and Proofs 9
- B0-211 Logic and Mathematical Inquiry 9
- B0-212 Arguments and Logical Analysis 9
- B0-310 Formal Logic 9
- B0-311 Undecidability and Incompleteness 9
- B0-312 Philosophy of Mathematics 9
- B0-313 Philosophical Logic 9
- B0-314 Logic and Artificial Intelligence 9
- B0-315 Modal Logic 9
- B0-411 Proof Theory 9
- B0-413 Category Theory 9
- B0-513 Seminar on Mathematical Understanding and Cognition 9
- B0-514 Categorical Logic Seminar 9

**Area 4: Epistemology/ Metaphysics** 9 units

One of the following:
- B0-201 Epistemology 9
- B0-208 Critical Thinking 9
- B0-220 Philosophy of Science 9
- B0-223 Philosophy of Social Science 9
- B0-226 Revolutions in Science 9
- B0-305 Rational Choice 9
- B0-321 Causation, Law, and Social Policy 9
- B0-322 Philosophy of Physics 9
- B0-323 Philosophy of Biology 9
- B0-405 Game Theory 9
- B0-516 Seminar on Causation 9
- B0-520 Seminar on Philosophy Science: Evolutionary Game Theory and Application 9
- B0-521 Seminar on Formal Epistemology 9
- B0-522 Seminar on the Foundation of Statistics 9

**Area 5: History of Philosophy** 18 units

Two of the following:
- B0-150 Nature of Reason 9
- B0-226 Revolutions in Science 9
- B0-250 Ancient Philosophy 9
- B0-251 Modern Philosophy 9
- B0-253 Continental Philosophy 9
- B0-254 Analytic Philosophy 9
- B0-255 Pragmatism 9
- B0-256 Modern Moral Philosophy 9
- B0-257 Nietzsche 9
- B0-261 Empiricism and Rationalism 9
- B0-264 William James and Philosophical Psychology 9
- B0-351 Kant 9
- B0-365 Ramsey 9

**Area 6: Electives** 27 units

Three other philosophy courses, or appropriate courses from other departments, with the permission of the Director.

Sample Curricula

Here are four sample curricula, reflecting different emphases.

**1. For an emphasis on Law & Social Policy, a student might take:**

**Area 1**
- B0-235 Political Philosophy 9

**Area 2**
- B0-180 Nature of Language 9

**Area 3**
- B0-211 Logic and Mathematical Inquiry 9

**Area 4**
- B0-208 Critical Thinking 9

**Area 5**
- B0-150 Nature of Reason 9

**Area 6**
- B0-321 Causation, Law, and Social Policy 9
- B0-348 Health Development and Human Rights 9
- B0-447 Global Justice 9

**2. For an emphasis on Philosophy of Science, a student might take:**

**Area 1**
- B0-136 Social Structure, Public Policy & Ethics 9

**Area 2**
- B0-275 Metaphysics 9

**Area 3**
- B0-211 Logic and Mathematical Inquiry 9

**Area 4**
- B0-220 Philosophy of Science 9

**Area 5**
- B0-250 Ancient Philosophy 9

**Area 6**
- B0-150 Nature of Reason 9

**3. For an emphasis on Ethics and Social Philosophy, a student might take:**

**Area 1**
- B0-230 Ethical Theory 9

**Area 2**
- B0-276 Philosophy of Religion 9

**Area 3**
- B0-110 Nature of Mathematical Reasoning 9

**Area 4**
- B0-221 Philosophy of Social Science 9
- B0-321 Causation, Law, and Social Policy 9

**Area 5**
- B0-250 Ancient Philosophy 9

**Area 6**
- B0-321 Causation, Law, and Social Policy 9

**4. For an emphasis on Philosophy of Mind, a student might take:**

**Area 1**
- B0-130 Introduction to Ethics 9

**Area 2**
- B0-270 Philosophy of Mind 9

**Area 3**
- B0-211 Logic and Mathematical Inquiry 9

**Area 4**
- B0-201 Epistemology 9

**Area 5**
- B0-251 Modern Philosophy 9
- B0-351 Kant 9

**Area 6**
- B0-275 Metaphysics 9
- B0-257 Nietzsche 9
- B0-314 Logic and Artificial Intelligence 9

Additional Major

Students who want an additional major in Philosophy must fulfill the same departmental requirements as primary majors in Philosophy.

The M.A. Program in Philosophy

The Department of Philosophy also offers a graduate M.A. degree in Philosophy, which culminates with the writing of a master’s thesis. It is ordinarily a two-year program, but students in the Philosophy major are able to complete the additional requirements in one year. Interested students are invited to visit the department’s homepage for further information: www.hss.cmu.edu/philosophy/.

Philosophy Department Minors

All majors in the Department allow for minors; in addition, there is a Minor in Ethics and an interdepartmental minor in Linguistics. The requirements are again designed to be flexible and to allow students to tailor courses to their special interests, while providing some breadth.

The Minor in Ethics

With the explosive growth of science and technology have come both new possibilities and new problems. Developments in medicine, in biology, in chemistry, in nuclear engineering or in computer science all have costs as well as benefits, and they present us with many hard choices. Some of the hardest of these new problems are moral problems.

The Philosophy Department’s Minor in Ethics introduces students to central ethical concepts and theories proposed and defended by the great philosophers of the past; it provides an understanding of how these theories and concepts can be applied to practical problems. This background in ethical theory and its applications should help students to respond more sensitively and appropriately to the new and unavoidable ethical problems that businesses, unions, and branches of government must face.

Ethics Core Courses 27 units

- B0-130 Introduction to Ethics 9
- B0-135 Introduction to Political Philosophy 9
- B0-136 Social Structure, Public Policy & Ethics 9
Ethics Electives 18 units
Complete two courses at the 200-level or higher.

The Minor in Linguistics
The interdepartmental Minor in Linguistics is jointly sponsored with the departments of English, Modern Languages, and Psychology. It synthesizes the linguistics related offerings in these departments and provides students with an academic experience that reflects both the interdisciplinary character of the subject and its cross-departmental representation in H&SS. Students who wish to receive a minor in Linguistics must complete six courses. For a detailed discussion of the curriculum and the flexible electives, consult the H&SS Interdisciplinary Minors section of the catalog.

The Minor in Logic and Computation
The Minor in Logic and Computation provides students with general course work in logic, the theory of computation, and philosophy. Students must complete six courses, among them the following three core courses.

Logic and Computation Core Courses 27 units
- 80-150 Nature of Reason 9
- 80-211 Logic and Mathematical Inquiry 9
- or 80-210 Logic and Proofs 9
- 80-310 Formal Logic 9
- or 80-311 Undecidability and Incompleteness 9

Logic and Computation Electives 27 units
Students must take two courses in the Philosophy Department at the 300-level or higher, in subjects related to logic and computation, and an additional course at the 300-level or higher in an area that uses logical and computational tools, such as philosophy, computer science, linguistics, mathematics, psychology, or statistics. The choice of electives must be approved by the program director.

The Minor in Philosophy
The Minor in Philosophy allows students to complement their primary majors with a broad philosophical grounding.

Logic/Methodology Requirements 9 units
Complete one course:
- 80-110 Nature of Mathematical Reasoning 9
- 80-210 Logic and Proofs 9
- 80-220 Philosophy of Science 9
- 80-221 Philosophy of Social Science 9
- 80-223 Philosophy of Economics 9
- 80-226 Revolutions in Science 9
- 80-310 Formal Logic 9
- 80-311 Undecidability and Incompleteness 9
- 80-312 Philosophy of Mathematics 9
- 80-314 Logic and Artificial Intelligence 9
- 80-315 Modal Logic 9
- 80-321 Causation, Law, and Social Policy 9
- 80-322 Philosophy of Physics 9
- 80-323 Philosophy of Biology 9
- 80-411 Proof Theory 9
- 80-413 Category Theory 9
- 80-513 Seminar on Mathematical Understanding and Cognition 9
- 80-514 Categorical Logic Seminar 9
- 80-516 Seminar on Causation 9
- 80-520 Seminar on Philosophy Science: Evolutionary Game Theory and Application 9
- 80-521 Seminar on Formal Epistemology 9
- 80-522 Seminar on the Foundation of Statistics 9

History of Philosophy Requirements 18 units
Complete two courses:
- 80-150 Nature of Reason 9
- 80-226 Revolutions in Science 9
- 80-250 Ancient Philosophy 9
- 80-251 Modern Philosophy 9
- 80-253 Continental Philosophy 9
- 80-254 Analytic Philosophy 9
- 80-255 Pragmatism 9
- 80-256 Modern Moral Philosophy 9
- 80-257 Nietzsche 9
- 80-261 Empiricism and Rationalism 9
- 80-264 William James and Philosophical Psychology 9
- 80-351 Kant 9
- 80-365 Ramsey 9

Philosophy Electives 18 units
Complete two courses in the Philosophy Department at the 200-level or higher.

The Honors Program
The H&SS Senior Honors Program provides recognition of outstanding performance by students majoring in Philosophy, Logic and Computation or Ethics, History, and Public Policy. Students have the opportunity to develop their skills and to apply their knowledge through completion of an honors thesis in their senior year. By completing the thesis, students earn 18 units of credit and qualify for graduation with College Honors. To qualify for the honors program, students must maintain a quality point average of at least 3.50 in the major and 3.25 overall, and be invited by the department to become a participant.

Undergraduate Research Fellows
Qualified upper level undergraduates, preferably majors in one of the Philosophy Department’s programs, may apply to serve in their junior or senior years as fellows in the Laboratory for Symbolic and Educational Computing. Applications are reviewed in the fall. Visit LSEC from the Department’s website: http://www.hss.cmu.edu/philosophy/labs-lsec.php.

Faculty
JEREMY AVIGAD, Professor of Philosophy – Ph.D., University of California, Berkeley; Carnegie Mellon, 1996–.
STEVEN AWODEY, Professor of Philosophy – Ph.D., University of Chicago; Carnegie Mellon, 1997–.
ROBERT CAVALIER, Teaching Professor of Philosophy – Ph.D., Duquesne University; Carnegie Mellon, 1987–.
DAVID DANKS, Associate Professor of Philosophy – Ph.D., University of California, San Diego; Carnegie Mellon, 2003–.
CLARK GLYMOUR, Alumni University Professor of Philosophy – Ph.D., Indiana University; Carnegie Mellon, 1984–.
MARALEE HARRELL, Associate Teaching Professor in Philosophy – Ph.D., University of California, San Diego; Carnegie Mellon, 2003–.
KEVIN T. KELLY, Professor of Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1985–.
ALEX LONDON, Associate Professor of Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1985–.
RICHARD SCHEINES, Professor of Philosophy – Ph.D., University of Virginia; Carnegie Mellon, 2000–.
TEDDY I. SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics – Ph.D., Columbia University; Carnegie Mellon, 1985–.
WILFRIED SIEG, Patrick Suppes Professor of Philosophy – Ph.D., Stanford University; Carnegie Mellon, 1985–.
MANDY SIMONS, Associate Professor of Philosophy – Ph.D., Cornell University; Carnegie Mellon, 1998–.
JOEL SMITH, Distinguished Career Teaching Professor – Ph.D., Cornell University; Carnegie Mellon, 1998–.
PETER L. SPIRTES, Professor of Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1987–.
KEVIN ZOLLMAN, Assistant Professor of Philosophy – Ph.D., University of California, Irvine; Carnegie Mellon, 2009–.

Special Faculty
ANDY NORMAN, – Ph.D., Northwestern University; .
JOSEPH RAMSEY, Director of Research Computing – Ph.D., University of California, San Diego; Carnegie Mellon, 2006–.
Adjunct Faculty
THOMAS WERNER, – Ph.D., Linguistics, Rutgers University;

Affiliated Faculty
PETER MADSEN, – Ph.D., Duquesne University;
SUSAN STERRETT, Research Associate – Ph.D., University of Pittsburgh;
GREGORY WHEELER, Visiting Associate Professor of Philosophy – Ph.D., University of Rochester; Carnegie Mellon, 2002–.
WAYNE WU, Assistant Professor and Associate Director of CNBC – Ph.D., University of California, Berkeley; Carnegie Mellon, 2010–.

Emeritus Faculty
DANA S. SCOTT, Hillman University Professor of Mathematical Logic, Computer Science and Philosophy (Emeritus) – Ph.D., Princeton University; Carnegie Mellon, 1981–.
The Major in Psychology

Psychology is a science that embraces both biological and social sciences. It is a science concerned with establishing principles and laws regarding the ways in which people think and behave through the scientific study of human behavior.

The orientation of the Carnegie Mellon Psychology curriculum is toward developing highly skilled and knowledgeable graduates. A bit more than half of the graduates go on to graduate or professional school. The remainder seek to expand their problem-oriented skills to qualify themselves for job opportunities beyond those typically open to liberal arts students, and are available.

Majors in the department are expected not only to learn about findings already established by psychologists, but also to become proficient in the investigation and analysis of behavior. This includes observing behavior, formulating hypotheses, designing experiments to test these hypotheses, running experiments, performing statistical analysis, and writing reports. The department has many resources for students to use in acquiring these skills. For instance, students interested in child development may be involved in the child development laboratory and observational facilities which are a part of the Carnegie Mellon Children’s School. Students interested in health psychology might have opportunities to work in applied settings, and all Psychology majors have access to extensive computer facilities for data analysis and simulation work. The department also has a state of the art set of undergraduate research laboratories and computer clusters, and has recently acquired, through the Scientific Imaging & Brain Research Center a magnet for conducting brain imaging studies using fMRI.

In addition to formal class work, students are encouraged to participate in research projects and field work via a number of opportunities available to them. They may register for Independent Reading in Psychology, Independent Research in Psychology, a research Internship course or an Internship in Clinical or Developmental Psychology. In the Independent Research course, the student may work on an ongoing research project or develop and carry out a new research project with a faculty member. There is university and departmental funding available to help support student-initiated research projects and student travel to present research results at scientific meetings and conferences. In the Readings courses, the student reads extensively on a particular topic. The faculty member and student meet to discuss the readings, and the student writes a paper on the topic selected. The Psychology Department Website (http://www.psy.cmu.edu), Graduate Catalog and Undergraduate Research Brochure provide descriptions of faculty (http://www.psy.cmu.edu/people/faculty.html) research interests that the student can use in determining who should be approached to supervise a particular research or reading project. Clinical internships are available with a variety of clinical settings including the prestigious Western Psychiatric Institute and Clinic (the teaching hospital of the Department of Psychiatry at the University of Pittsburgh). During the internship, students get first-hand experience with different clinical populations. Developmental Internships are available in the department-run CMU Children’s School (http://www.psy.cmu.edu/cscs). Finally, outstanding students are invited to participate in an Honors Program during their senior year. Over the course of their senior year, these students develop and carry out an original research project under faculty supervision.

Psychology Curriculum

The curriculum includes three levels of psychological course work. These result in a breadth of knowledge of psychology, training in research methods, and in-depth advanced course work in student chosen areas of psychology. Both the B.A. and the B.S. degrees are available in Psychology. Candidates for both degrees must also complete two semesters of calculus. There are three options in completing this requirement: 21-111/21-112 or 21-120 and either 21-122 or 21-256. Students are also required to complete a statistics sequence consisting of 36-201 or it’s equivalent, followed by 36-309, Experimental Design. Both courses should be completed if possible, before the junior year. A one-semester computer programming course is also required for all Psychology majors. Finally, in addition to the H&SS General Education Natural Science requirement, B.A. candidates take one and, B.S. candidates take three additional semesters of natural science courses outside the department. This breadth of technical and scientific preparation has proven to be valuable both for students going on to graduate or professional schools and those entering the job market upon graduation.

The Department desires that majors acquire both breadth and depth in the subject matter of Psychology. The requirement for demonstration of breadth can be met by taking Introduction to Psychology (85-102) and three 200 level survey courses. It is recommended that this be started as early as possible in the student’s program. Alternatively, the breadth requirement can be met by taking an additional Survey course beyond the required set of three as a substitution for the intro course. As mentioned earlier, the curriculum is also organized into three broad areas of psychology; cognitive and cognitive neuroscience, developmental and social, personality, and health, each including a survey course, a research methods and an array of advanced seminars that allow students to develop depth of knowledge within a chosen area.

Overall, the major includes Introduction to Psychology (or a 4th survey course), 36-309, three survey courses at the 200-level, two research methods courses, two advanced courses and an experimental design course taught in the department of Statistics. These include a total of 81 units. Advanced courses, which are often in the form of seminars, examine in great depth different sub areas of psychology. The 18-unit advanced course requirement must be fulfilled by taking content seminars or courses rather than through Independent Research, Independent Reading, or Internship courses. In addition to the small number of required psychology courses, the department offers a variety of other courses, seminars, independent research and supervised experiences and students are encouraged to sample these by means of the large number of elective units that are part of the program.

Prospective Psychology majors are encouraged to begin major requirements and prerequisites prior to the junior year, if possible. In particular, completion of the calculus and statistics sequences, Introduction to Psychology and/or one or more Psychology Survey courses would enable students to take corresponding research methods courses in the sophomore or early in the junior year, and thus prepare themselves to take advantage of research opportunities in the department.

Mathematics & Statistics Prerequisites 37-38 units

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>21-111/21-112</td>
<td>Calculus I and Calculus II</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-256</td>
<td>Statistical Reasoning and Practice</td>
</tr>
<tr>
<td>21-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
</tr>
</tbody>
</table>

Breadth Requirement 9 units

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
</tr>
</tbody>
</table>

* This, together with three survey courses, constitutes the breadth requirement.
Survey Courses 27 units
Complete three of the following survey courses.
85-211 Cognitive Psychology 9
or 85-213 Human Information Processing and Artificial Intelligence 9
85-219 Biological Foundations of Behavior 9
85-221 Principles of Child Development 9
85-241 Social Psychology 9
85-251 Personality 9

Research Methods 18 units
Complete two courses.
85-310 Research Methods in Cognitive Psychology * 9
85-320 Research Methods in Developmental Psychology * 9

* Prerequisites for all Research Methods courses: 36-309 or equivalent, and corresponding survey course.
(Note: 36-309 may be taken concurrently as a co-requisite)

Advanced Courses 18 units
Complete two courses.

Computer Science Requirement 10 units minimum
15-101 Exploring Programming with Alice or 15-110 Principles of Computing

Natural Science Requirement (B.A. 18 units, B.S. 36 units, which includes 9 units of GenEd Science)
The Psychology major requires (for B.S. candidates) three additional natural science courses (with two in the same science) beyond the College’s General Education natural science requirement. For the B.A. the requirement is one course beyond the General Education requirement in natural science. Given the growing relevance of biology to psychology, it is strongly recommended that for the B.S. a minimum of two courses in biology be included as part of the natural science requirement.

More generally, for the B.S., at least two courses should come from the same science (biology, chemistry, or physics).

Additional Major in Psychology
In order to complete an additional major in Psychology, a student must fulfill all of the Psychology major requirements within the department in other words, the breadth requirement, computing requirement, three survey courses at the 200-level, two research methods courses, and two advanced courses. These courses must include at least 81 units, plus calculus prerequisites and the 36-201 statistics course or equivalent and 36-309. In addition, B.S. candidates must take the three-course science requirement and B.A. candidate will complete one science course beyond the GenEd requirement.

Neurosciences Within Psychology
The Psychology Department at Carnegie Mellon University has a major focus on the role of the brain and nervous system in cognition and behavior, including biological approaches involving the health impact that arises from the interaction of behavior with the nervous, endocrine, and immune systems. These interests are manifested in faculty research (http://coursecatalog.web.cmu.edu/dietrichcollegeofhumanitiesandsocialsciences/departmentofpsychology/www.psy.cmu.edu), departmental and university centers that operate from or heavily involve the department (e.g., the Center for Cognitive Brain Imaging (http://www.ccbi.cmu.edu), and the Center for the Neural Basis of Cognition (http://www.cnbc.cmu.edu)) as well as undergraduate coursework (http://www.psy.cmu.edu/undergrad_program) and graduate coursework. For undergraduates, there are a number of ways in which students with an interest in these approaches can pursue that interest in an organized fashion. These include the following:
• For students interested in computational as well as neural approaches to cognition, the choice of the Cognitive Science major (http://www.psy.cmu.edu/undergrad_program) with a concentration in Cognitive Neuroscience within that major, and additionally, if desired, the choice of a minor in Computational Neuroscience.
• For students interested in brain-behavior interactions or in Health Psychology, there is a choice of a Psychology major with a concentration in either Cognitive Neuroscience, or a concentration in Health Psychology.

• For students desiring more broad-based as well as deep preparation in both Psychology and Biology (http://www.psy.cmu.edu/undergrad_program) there is a unified double major within which students interested in Cognitive Neuroscience or Neuroscience can pick the Neuroscience Track within the Biology part of the major and/or the Cognitive Neuroscience concentration within the Psychology part of the major. Those with an interest in health psychology and/or medical school can pursue the unified double major with a Health Psychology concentration within the Psychology portion of the major.

Finally, for any interested student, there is a minor in Cognitive Neuroscience available through either the Psychology or Biology department (see below).

Unified Double Major in Psychology & Biological Sciences
This major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences.

Note: Students entering from the College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the Mellon College of Science will earn a Bachelor of Science in Biological Sciences and Psychology. Students in the joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Depending on a student’s home college (H&SS or MCS), General Education (GenEd) requirements will be different. GenEd requirements for H&SS (p.168) and MCS (p. 253) are found on their respective Catalog pages.

Degree Requirements:

<table>
<thead>
<tr>
<th>Biological Sciences</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231 Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-201/202 Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxx General Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xxx Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xxx Advanced Biology Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Biology units 79

Mathematics, Statistics, Physics and Computer Science

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>02-124 Calculus II for Biologists and Chemists</td>
</tr>
<tr>
<td>36-247 Statistics for Lab Sciences</td>
</tr>
<tr>
<td>36-309 Experimental Design for Behavioral and Social Sciences</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
</tr>
<tr>
<td>33-112 Physics II for Science Students</td>
</tr>
<tr>
<td>15-110 Principles of Computing *</td>
</tr>
<tr>
<td>99-10x Computing at Carnegie Mellon</td>
</tr>
</tbody>
</table>

Total Science units 75

* 15-101 Exploring Programming with Alice can substitute for 15-110 towards completion of the Programming course requirement.
The Major in Cognitive Science

The Psychology Department offers a B.S. degree in Cognitive Science. The field of cognitive science has grown out of increasingly active interaction among psychology, linguistics, artificial intelligence, philosophy, and neuroscience. All of these fields share the goal of understanding intelligence. By combining these diverse perspectives, students of cognitive science are able to understand cognition at a deep level. Because this major is administered by the Psychology Department, it focuses on human cognition and the experimental study of the human mind as illuminated by the techniques of the above disciplines.

Cognitive Science Curriculum

The Cognitive Science major is only offered as a B.S. degree. Candidates should complete before the junior year the two-semester calculus sequence 21-120 / 21-256 (or alternatively 21-120/21-122)* and a statistics sequence (36-201 or equivalent and if possible, 36-309 ). In addition, candidates complete 15-112 Fundamentals of Programming and Computer Science, as their departmental computing course. Because of the number and sequential nature of required courses, prospective Cognitive Science majors are encouraged to begin course work for the major prior to the junior year. In particular, completion of calculus, 36-201, and 85-211 or 85-213 before the junior year will enable students to complete 85-310 by the fall semester of the junior year and, if interested, to then take advantage of research opportunities in the department.

Similarly, completion of 15-122 and 21-127 early in their program of studies will allow students to move into the 15-150 /15-251 sequence by the junior year and prepare them for further work in artificial intelligence.

*The 3-Semester sequence 21-111 /21-112/21-256 may be substituted by students who have already taken 21-111 before deciding on the major.

Computing Prerequisite 10 units
15-112 Fundamentals of Programming and Computer Science 12

Mathematics & Statistics Prerequisites 37-38 units
21-120 / 21-256 Differential and Integral Calculus 19
and Multivariate Analysis *
or 21-120 Differential and Integral Calculus 19
6.21-122 and Integration, Differential Equations and Approximation 19
21-127 Concepts of Mathematics 10
36-201 Statistical Reasoning and Practice 9
36-309 Experimental Design for Behavioral and Social Sciences 9

The Major in Cognitive Science

Computational/ 29–31 units Cognitive Modeling Core

Two of the following: 15-122 Principles of Imperative Computation 10
15-150 Principles of Functional Programming 10
15-251 Great Theoretical Ideas in Computer Science 12

Plus one of the following: 85-412 Cognitive Modeling 9
85-419 Introduction to Parallel Distributed Processing 9
85-426 Learning in Humans and Machines 9

Cognitive Psychology Core

85-211 Cognitive Psychology 9
or 85-213 Human Information Processing and Artificial Intelligence 9
85-310 Research Methods in Cognitive Psychology 9

One of the following: 85-219 Biological Foundations of Behavior 9
85-355 Introduction to Cognitive Neuroscience 9
85-414 Cognitive Neuropsychology 9

Cognitive Science Concentration (4 courses, concentration approval required)

These four courses are chosen in conjunction with your advisor to form a coherent area of concentration from the course list under "Cognitive Science Concentration" in the current Undergraduate Catalog. Before proceeding with the choice of courses, students must fill out the concentration form, obtained from their advisor, with a description of the concentration area and the planned set of four courses. Courses not represented on the list may, with pre-approval of advisor and department, be used to satisfy part of this requirement.

36 units

Computer Science

15-384 Robotic Manipulation 12
15-385 Computer Vision 9
15-453 Formal Languages, Automata, and Computability 9
10-601 Machine Learning 12
05-410 User-Centered Research and Evaluation 12
05-412 Cognitive Modeling and Intelligent Tutoring Systems 9

Psychology

85-219 Biological Foundations of Behavior 9
85-352 Evolutionary Psychology 9
85-355 Introduction to Cognitive Neuroscience 9
85-370 Perception 9
85-375 Crosscultural Psychology 9
85-380 In Search of Mind: The History of Psychology 9
85-382 Consciousness and Cognition 9
85-390 Human Memory 9
85-392 Human Expertise 9
85-395 Applications of Cognitive Science 9
85-406 Autism: Psychological and Neuroscience Perspectives 9
85-412 Cognitive Modeling 9
85-414 Cognitive Neuropsychology 9
85-419 Introduction to Parallel Distributed Processing 9
85-421 Language and Thought 9
85-422 Infancy 9
85-423 Cognitive Development 9
85-426 Learning in Humans and Machines 9
85-429 Cognitive Brain Imaging 9
85-601/602 Senior Thesis 9
66-501/502 H&SS Senior Honors Thesis I 9

Philosophy

80-210 Logic and Proofs 9
80-211 Logic and Mathematical Inquiry 9
80-220 Philosophy of Science 9
80-254 Analytic Philosophy 9
80-255 Pragmatism 9
80-270 Philosophy of Mind 9
80-310 Formal Logic 9
80-311 Underdetermination and Incompleteness 9
80-314 Logic and Artificial Intelligence 9

Linguistics

76-385 Introduction to Discourse Analysis 9
80-280 Linguistic Analysis 9

Decision Sciences

88-302 Behavioral Decision Making 9
Neurosciences

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-363</td>
<td>Systems Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>15-883</td>
<td>Computational Models of Neural Systems</td>
<td>12</td>
</tr>
</tbody>
</table>

Appropriate courses offered by the Department of Neuroscience at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this breadth option. This would include the following courses (course numbers are University of Pittsburgh numbers, offered through its Department of Neuroscience):

- NROSCI1000 Introduction to Neuroscience
- NROSCI1011 Functional Neuroanatomy
- NROSCI1012 Neurophysiology
- NROSCI1017 Synaptic Transmission
- NROSCI1030 Psychiatric Disorders and Brain Function
- NROSCI1032 Function Organization of the Human Nervous System
- NROSCI1034 Neural Basis of Cognition
- NROSCI1036 Neurobiology of Aging
- NROSCI1140 Biological Basis of Learning and Memory
- NROSCI1141 Developmental Neuroscience
- NROSCI1142 Neurochemical Basis of Behavior

Supplementary Science Requirement (minimum) 18 units

The Cognitive Science program requires two additional science courses (in the same sequence) beyond the college’s two-course Science and Technology General Education requirement.

These can be selected from any one of the following areas.

03-xxx Biology
09-xxx Chemistry

* Those interested in a cognitive neuroscience focus are recommended to take biology courses, including if possible, 03-362, or 03-363.

Additional Major in Cognitive Science

In order to complete a double major in Cognitive Science, a student must fulfill the major requirements as listed under the Cognitive Science major. These include the programming requirement (15-112), the Mathematics and Statistics prerequisites, Computational/Cognitive Modeling Core, The Cognitive Psychology Core, the Cognitive Science Concentration Requirement, and the Supplementary Science Requirement. Students will be assigned a department advisor to help plan their program of studies in Cognitive Science.

Minors in Psychology, Neuroscience and Cognitive Neuroscience

These are available to all students across the university.

Minor in Psychology

73 unitsCurriculum - Psychology Minor

I. Introductory course

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-101</td>
<td>Introduction to Psychology</td>
<td>9</td>
</tr>
</tbody>
</table>

II. Area Survey courses Complete two courses.

- 85-211 Cognitive Psychology
- 85-213 Human Information Processing and Artificial Intelligence
- 85-219 Biological Foundations of Behavior
- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 85-251 Personality

III. Statistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

Upper Level Courses 27 units Complete three courses from categories IV and V, with at least one course from each.

IV. Research Methods Courses (minimum 9 units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-310</td>
<td>Research Methods in Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-320</td>
<td>Research Methods in Developmental Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-340</td>
<td>Research Methods in Social Psychology</td>
<td>9</td>
</tr>
</tbody>
</table>

* Prerequisites for all Research Methods courses: 36-309 and the appropriate survey course.

(Note: 36-309 may be taken concurrently as a co-requisite.)

V. Advanced courses (minimum 9 units)

These courses exist within three areas (cognitive, cognitive neuroscience, developmental and social psychology), and carry course numbers from 85-311 to 85-442. In cases where it is not obvious which track an advanced course belongs to from the title/description, the advanced courses usually include the appropriate survey course or research method course as a prerequisite in their catalog course description.

Minor in Cognitive Neuroscience

The minor in Cognitive Neuroscience offered by the Department of Psychology is designed to interface with the Neuroscience Minor offered by the Department of Biological Sciences. The differences between the two forms of the minor are determined by one required course, and additionally, by the students’ choice of distribution electives.

The requirements for the Cognitive Neuroscience Minor include 7 courses: four required courses, and three distribution and elective courses.

Curriculum - Cognitive Neuroscience

Required coursework: | Units |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>03-322</td>
<td>Modern Biology 9</td>
</tr>
<tr>
<td>03-363</td>
<td>Systems Neuroscience 9</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior 9</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology 9</td>
</tr>
</tbody>
</table>

Students pursuing the Neuroscience Minor through the Department of Biological Science would take 03-362 Cellular Neuroscience instead.

Distribution Requirements: Three Courses, including at least 1 from each of the following categories:

- Approaches to Cognitive Neuroscience

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-355</td>
<td>Introduction to Cognitive Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-414</td>
<td>Cognitive Neuropsychology</td>
<td>9</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
<tr>
<td>85-429</td>
<td>Cognitive Brain Imaging</td>
<td>9</td>
</tr>
<tr>
<td>03-315</td>
<td>Magnetic Resonance Imaging</td>
<td>9</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>15-883</td>
<td>Computational Models of Neural Systems</td>
<td>12</td>
</tr>
</tbody>
</table>

36-746 Statistical Methods for Neuroscience is also a possible choice offered intermittently.

Cognitive Neuroscience Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-364</td>
<td>Developmental Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-761</td>
<td>Neural Plasticity</td>
<td>9</td>
</tr>
<tr>
<td>15-486</td>
<td>Artificial Neural Networks</td>
<td>12</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-356</td>
<td>Music and Mind: The Cognitive Neuroscience of Sound</td>
<td>9</td>
</tr>
<tr>
<td>85-370</td>
<td>Perception</td>
<td>9</td>
</tr>
<tr>
<td>85-390</td>
<td>Human Memory</td>
<td>9</td>
</tr>
<tr>
<td>85-406</td>
<td>Autom. Psychological and Neuroscience Perspectives</td>
<td>9</td>
</tr>
</tbody>
</table>

Concentrations within the Psychology Major

Students who wish to focus their Psychology program on a specific area can do so either by the careful selection of Psychology elective courses that focus on their area of interest or by pursuing one of the following concentrations with the approval of the student’s Psychology advisor. The latter option involves picking up copies of a concentration form from the Undergraduate Program Coordinator, Emilie Rendulic, and having the advisor sign off on the agreed upon concentration courses, with copies of the form kept by the student, the advisor and the department. The completion of a concentration will be recognized in the Psychology Graduation Brochure.

Health-Psychology Concentration

For Psychology majors who wish to have a focus of their study on Health Psychology, the following courses should be selected as part of their Psychology Major in conjunction with their Psychology advisor’s approval.

As part of the B.S. science requirement:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
</tbody>
</table>

+ one additional Biology course

As part of the psychology breadth requirement, at least two of the following:

85-219 Biological Foundations of Behavior
85-241 Social Psychology
Additional Course Requirement choose one of the following:

- 03-350 Developmental Biology
- 03-330 Genetics
- 85-501 Stress, Coping and Well-Being

Cognitive-Neuroscience Concentration
For Psychology majors who wish to have a focus of their study be on Cognitive Neuroscience, the following courses should be selected as part of their Psychology Major in conjunction with their Psychology advisor’s approval.

As part of the B.S. Science requirement:

- 03-121 Modern Biology
- 03-363 Systems Neuroscience

As part of the psychology Breadth requirement:

- 85-211 Cognitive Psychology
- 85-219 Biological Foundations of Behavior

As part of the Research Methods requirement:

- 85-310 Research Methods in Cognitive Psychology

As part of the advanced coursework in psychology requirement, at least two of the following:

- 85-356 Music and Mind: The Cognitive Neuroscience of Sound
- 85-370 Perception
- 85-406 Autism: Psychological and Neuroscience Perspectives
- 85-414 Cognitive Neuropsychology
- 85-419 Introduction to Parallel Distributed Processing
- 85-429 Cognitive Brain Imaging

Developmental Psychology Concentration
For Psychology majors who wish to have a focus of their study be on Developmental Psychology, the following courses should be selected as part of their Psychology Major in conjunction with their Psychology advisor’s approval.

As part of the B.S. science requirement:

- 03-121 Modern Biology

As part of the psychology Breadth requirement:

- 85-211 Cognitive Psychology

As part of the psychology Research Requirement:

- 85-320 Research Methods in Developmental Psychology

As part of the advanced coursework in psychology requirement, at least two of the following:

- 85-354 Infant Language Development
- 85-363 Attention, Its Development and Disorders
- 85-406 Autism: Psychological and Neuroscience Perspectives
- 85-423 Cognitive Development

Additional course requirement, one of the following:

- 85-484 Practicum in Child Development
- 03-330 Genetics
- 03-350 Developmental Biology

Additional Course Requirement choose one of the following:

- 85-507 Research in Psychology or 85-508 Research in Psychology in Development
- or an additional advanced seminar in Development

Cognitive Psychology Concentration
For Psychology majors who wish to have a focus of their study be on Cognitive Psychology and/or Cognitive Modeling, the following courses should be selected as part of their Psychology Major in conjunction with their Psychology advisor’s approval.

As part of the B.S. science requirement:

- 03-121 Modern Biology

As part of the psychology Breadth requirement:

- 85-211 Cognitive Psychology

As part of the psychology Research Methods requirement:

- 85-310 Research Methods in Cognitive Psychology

As part of the advanced coursework in psychology requirement, at least two of the following:

- 85-355 Introduction to Cognitive Neuroscience
- 85-356 Music and Mind: The Cognitive Neuroscience of Sound
- 85-370 Perception
- 85-380 In Search of Mind: The History of Psychology
- 85-390 Human Memory
- 85-392 Human Expertise
- 85-395 Applications of Cognitive Science
- 85-406 Autism: Psychological and Neuroscience Perspectives
- 85-412 Cognitive Modeling
- 85-414 Cognitive Neuropsychology
- 85-419 Introduction to Parallel Distributed Processing
- 85-421 Language and Thought
- 85-426 Learning in Humans and Machines

Additional Course Requirement choose one of the following:

- 85-507 Research in Psychology or 85-508 Research in Psychology in Cognition
- or an additional advanced seminar in Cognition

Social-Personality Psychology Concentration
For Psychology majors who wish to have a focus of their study be on Social and/or Personality Psychology, the following courses should be selected as part of their Psychology Major in conjunction with their Psychology advisor’s approval.

As part of the Psychology breadth requirement:

- 85-241 Social Psychology
- 85-251 Personality

As part of the Psychology research methods requirement:


As part of the advanced coursework in psychology requirement, at least two of the following:

- 85-352 Evolutionary Psychology
- 85-358 Pro-Social Behavior
- 85-375 Crosscultural Psychology
- 85-377 Attitudes and Persuasion
- 85-443 Social Factors and Well-Being
- 85-444 Relationships
- 85-446 Psychology of Gender
- 85-501 Stress, Coping and Well-Being

Additional Course Requirement choose one of the following:

- 85-507 Research in Psychology or 85-508 Research in Psychology in Social/Personality
- or an additional advanced seminar in Social/Personality

The Honors Program
The Honors Program provides recognition of outstanding performance by students in Psychology or Cognitive Science. Participation enables students to pursue their own research ideas through completion of an honors thesis. The honors thesis is completed during the senior year. By completing a thesis, the student earns 18 units of credit and qualifies for graduation.
with “College Honors.” To qualify for the Honors Program, the student must maintain a quality point average of at least 3.50 in the major and 3.25 overall, and be invited by the college to become a participant. A year long senior thesis course exists for students interested in pursuing a sizable research project who do not qualify for the honors program.

Faculty

JOHN R. ANDERSON, Richard King Mellon University Professor of Psychology and Computer Science – Ph.D., Stanford University; Carnegie Mellon, 1978–.

MARLENE BEHRMANN, Professor of Psychology – Ph.D., University of Toronto; Carnegie Mellon, 1993–.

SHARON CARVER, Director of Children's School, Teaching Professor of Psychology – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993–.

SHELDON COHEN, Robert E. Doherty Professor of Psychology – Ph.D., New York University; Carnegie Mellon, 1982–.

CHANTE COX-BOYD, Associate Teaching Professor – Ph.D., University of North Carolina at Chapel Hill; Carnegie Mellon, 2001–.

DAVID CRESWELL, Assistant Professor – Ph.D., University of California, Los Angeles; Carnegie Mellon, 2008–.

BROOKE C. FEENEY, Associate Professor of Psychology – Ph.D., State University of New York at Buffalo; Carnegie Mellon, 2001–.

ANNA FISHER, Associate Professor – Ph.D., The Ohio State University; Carnegie Mellon, 2006–.

JOHN R. HAYES, Emeritus Professor of Psychology – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1965–.

VICKI S. HELGESON, Professor of Psychology – Ph.D., University of Denver; Carnegie Mellon, 1990–.

LAURIE HELLER, Associate Teaching Professor – Ph.D., University of Pennsylvania; Carnegie Mellon, 2009–.

LORI L. HOLT, Associate Professor – Ph.D., University of Wisconsin; Carnegie Mellon, 1999–.

MARCEL A. JUST, D. O. Hebb Professor of Psychology – Ph.D., Stanford University; Carnegie Mellon, 1972–.

CHARLES KEMP, Assistant Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2008–.

DAVID KLAHR, Walter van Dyke Bingham Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969–.

ROBERTA KLATZKY, Professor of Psychology – Ph.D., Stanford University; Carnegie Mellon, 1993–.

KENNETH R. KOEDINGER, Professor of HCII – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001–.

KENNETH KOTOVSKY, Professor of Psychology, Director, Undergraduate Studies in Psychology – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988–.

MARSHA C. LOVETT, Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000–.

BRIAN MACWHINNEY, Professor of Psychology – Ph.D., University of California, Berkeley; Carnegie Mellon, 1981–.

DAVID PLAUT, Professor of Psychology – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994–.

DAVID RAKISON, Associate Professor – D.Phil., University of Sussex; Carnegie Mellon, 2000–.

LYNNE M. REDER, Professor of Psychology – Ph.D., University of Michigan; Carnegie Mellon, 1978–.

MICHAEL F. SCHIEBER, Professor of Psychology, Head, Psychology Department – Ph.D., University of Texas; Carnegie Mellon, 1975–.

ROBERT S. SIEGLER, Theresa Heinz Professor of Psychology – Ph.D., State University of New York, Stony Brook; Carnegie Mellon, 1974–.

JAMES J. STASZEWSKI, Research Professor – Ph.D., Cornell University; Carnegie Mellon, 1995–.

MICHAEL TARR, Professor of Psychology – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2009–.

ERIK D. THEISSEN, Associate Professor – Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2004–.
Department of Social and Decision Sciences

Department Office: Porter Hall 208
http://www.cmu.edu/dietrich/sds/

The Department of Social and Decision Sciences is a multidisciplinary department that offers undergraduate programs that seamlessly combine frontier knowledge in the social sciences with the practical skills needed to excel in key decision making roles in the public and private sectors and in advanced studies. Our students learn how to combine intellectual ideals with the realities of human and organizational behavior and to apply these lessons across a wide variety of endeavors, ranging from government service to leadership positions in the information economy.

The department offers undergraduate majors in Decision Science, International Relations and Politics, and Policy and Management. The majors leverage off of our departmental core that includes courses in decision analysis, empirical research, organizations, and policy analysis. In addition to complementing the core, students also specialize in their major area through a set of required and elective courses.

Our faculty is committed to the academic success and growth of our students and many of our undergraduates work with faculty on research projects and internships. The directors of the majors are easily accessible and encourage students to talk with them about their curriculum, progress, and available opportunities.

The Department of Social and Decision Sciences has a long history of creating innovative and prescient undergraduate programs that combine key ideas from across the social sciences into cohesive majors that allow our graduates to excel in their chosen professions or in the pursuit of advanced studies. Our emphasis on the theory and practice of individual and social decision making linked with our high-quality, multidisciplinary social science faculty, provides a solid foundation from which graduates can embrace a variety of future paths.

The Major in Decision Science

Baruch Fischhoff, Faculty Director
Office: Porter Hall 219E
Connie Angermeier, Academic Advisor
Office: Porter Hall 208A
Email: cia2@andrew.cmu.edu

The interdisciplinary field of Decision Science seeks to understand and improve the judgment and decision making of individuals, groups, and organizations. Qualified graduates can continue to PhD programs in Decision Science or related fields (e.g., psychology, business), pursue professional degrees (e.g., MBA, MD, JD, MPH), or take professional positions in business, government, consulting, or the non-profit sector. Students work with faculty to tailor their education to their specific needs and interest.

Carnegie Mellon is one of the leading centers for the study of Decision Science - and offers the only such undergraduate major. Our faculty are involved in applying Decision Science in a wide variety of areas, allowing them to share practical experiences with students. These applications include medical decision making (e.g., conveying the costs and benefits of treatment options), legal decision making (e.g., understanding the effects of anger on attributions of responsibility), risk management (e.g., assessing and communicating the risks of terrorist attacks), marketing (e.g., understanding the effects of interference on purchasing decisions), and business (e.g., identifying unrecognized conflicts of interest).

Decision Science is grounded in theories and methods drawn from psychology, economics, philosophy, statistics, and management science. Courses in the major cover the three aspects of decision science: (a) normative analysis, creating formal models of rational choice; (b) descriptive research, studying how cognitive, emotional, social, and institutional factors affect judgment and choice, and (c) prescriptive interventions, seeking to improve judgment and decision making. In addition to gaining a broad education in the principles of judgment and decision making, Decision Science majors gain broadly applicable skills in research design and analysis. They also have the chance to think about and discuss decision making in many different areas.

The core courses in Decision Science cluster into two categories. The theory cluster presents fundamental theories and results from the empirical study of decision making, as well as the application of decision-making research to real-world problems. The research methods cluster introduces students to methods for collecting and analyzing behavioral data. For example, students learn to conduct surveys (e.g., uncovering consumer or managerial preferences), design experiments evaluating psychological and economic theories, and evaluate the effectiveness of interventions.

The elective courses provide students with additional knowledge in areas of decision making that meet their personal, intellectual, and career goals. These courses are organized into six clusters: biological and behavioral aspects of decision making, managerial and organizational aspects, philosophical and ethical perspectives, economic and statistical methods, public policy, and research methods. Students can concentrate in one area or spread their studies across them. In addition to coursework, the department offers research opportunities for interested and qualified students. Participating in research helps students to extend their mastery of decision science, discover whether a research career is right for them, and get to know faculty and graduate students better.

Prerequisites

All Decision Science majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

<table>
<thead>
<tr>
<th>Mathematics Prerequisite</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-111-21-112 Calculus I</td>
<td>10-20</td>
</tr>
<tr>
<td>and Calculus II</td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10-20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistics Prerequisite</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
</tbody>
</table>

Curriculum 108 units

The core curriculum in Decision Science consists of two courses in empirical research methods and five courses providing the disciplinary perspectives of Decision Science.

<table>
<thead>
<tr>
<th>Disciplinary Perspectives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-120 Reason, Passion and Cognition **</td>
<td>9</td>
</tr>
<tr>
<td>85-211 Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>88-220 Policy Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>88-223 Decision Analysis and Decision Support Systems</td>
<td>9</td>
</tr>
<tr>
<td>88-302 Behavioral Decision Making</td>
<td>9</td>
</tr>
</tbody>
</table>

** 88-120 should be taken in the freshman or sophomore year.

Research Methods

<table>
<thead>
<tr>
<th>Research Methods</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>88-251 Empirical Research Methods</td>
<td>18</td>
</tr>
</tbody>
</table>

Electives 45 units

Complete at least 45 units of courses from the following categories of courses. The selected courses may be from one category or from any combination of categories. Note that not all elective courses are offered every year.

At least three of these courses (27 units) must be Department of Social and Decision Sciences courses (88-xxx).

1. Biological and Behavioral Aspects of Decision Making

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-352 Evolutionary Psychology</td>
</tr>
<tr>
<td>85-492 Health Psychology</td>
</tr>
<tr>
<td>88-365 Behavioral Economics</td>
</tr>
<tr>
<td>88-377 Attitudes and Persuasion</td>
</tr>
<tr>
<td>88-388 Psychological Models of Decision Making</td>
</tr>
<tr>
<td>88-421 Emotion: Physiology, Neuropsychology, Expression, and Decision Making</td>
</tr>
</tbody>
</table>

2. Managerial and Organizational Aspects of Decision Making

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-381 Marketing I</td>
</tr>
<tr>
<td>70-460 Mathematical Models for Consulting</td>
</tr>
<tr>
<td>88-221 Policy Analysis I</td>
</tr>
<tr>
<td>88-419 Negotiation</td>
</tr>
<tr>
<td>88-444 Public Policy and Regulation</td>
</tr>
<tr>
<td>88-451 Policy Analysis Senior Project</td>
</tr>
<tr>
<td>or 88-452 Policy Analysis Senior Project</td>
</tr>
</tbody>
</table>

3. Philosophical and Ethical Perspectives on Decision Making

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-426 Environmental Decision Making</td>
</tr>
<tr>
<td>80-208 Critical Thinking</td>
</tr>
<tr>
<td>80-221 Philosophy of Social Science</td>
</tr>
</tbody>
</table>
Students pursuing International Relations and Politics with an additional major in Decision Science may only count 36-202, 88-220, and 88-251 toward the completion of both majors.

Students pursuing Policy and Management with an additional major in Decision Science may only count 36-202, 88-220, 88-223, and 88-251 toward the completion of both majors.

Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor. Students who are interested in an additional major in Decision Science should see the Academic Advisor of the Decision Science program.

The Major in International Relations and Politics

Kiron K. Skinner, Faculty Director; kskinner@andrew.cmu.edu

Emily Half, Academic Advisor; ehalf@andrew.cmu.edu, Baker Hall A60C, 412-268-7082

http://www.cmu.edu/ir

The International Relations and Politics (IRP) major analyzes the role of politics at the national, regional, international, and transnational levels; examines political arrangements within and among these levels; and investigates the phenomenon of globalization. Statesmen, scholars, and policy makers often discuss globalization in terms of the deepening economic and political integration among states. Building on Carnegie Mellon University’s interdisciplinary approach to research, the IRP major investigates globalization as the intersection of international politics, culture, markets, and technology. Furthermore, the major examines, through interdisciplinary intellectual lenses, the way in which states construct grand strategy and the effect of grand strategy on the international system.

No single discipline can grapple fully with the ever-evolving process of globalization and the role played by grand strategy. The IRP major, rooted in the discipline of political science, relies upon analytical social science for important insights into these complex areas. The major also utilizes the intellectual strengths of the Department of Social and Decision Sciences, which include behavioral decision science, history, complex social systems, economics, and the department’s program in strategy, entrepreneurship, and technological change. Students’ understanding of globalization, international politics, and grand strategy is further informed by courses and colloquia offered by CMU’s top-ranked departments, divisions, and schools in business, computer science, engineering, and the humanities.

Knowledge of the theoretical underpinnings of international relations is the core objective of IRP. Thus, students pursuing this major will be trained to apply analytic tools to enduring problems in the international system. These tools include rational choice theory, political history, economic analysis, and theories of behavioral decision making.

Students are required to complete the intermediate (200) level, or its equivalent, in a modern language other than English. Advanced-level study is strongly encouraged.

Open to all Carnegie Mellon undergraduates, Carnegie Mellon University’s Washington Semester Program (http://www.cmu.edu/ir/academic-programs/washington-semester-program) (CMUWSP) allows students to study public policy and intern in Washington for one semester. Courses taken through CMUWSP will count toward elective sequence requirements for IRP majors.

IRP majors interested in developing their research skills are encouraged to apply for a research position with the Center for International Relations and Politics. They are also encouraged to join student organizations focused on domestic or international politics. Becoming involved in the Social and Decision Sciences Department (SDS) and the Student Advising Council (SAC), as well as attending lectures and events sponsored by the Center for International Relations and Politics and SDS, will provide additional opportunities for students.

The International Relations and Politics major is offered through the Department of Social and Decision Sciences. It is available as a primary major and an additional major in the Dietrich College of Humanities and Social Sciences.

Prerequisites

All International Relations and Politics majors must complete mathematics and statistics prerequisites (see below) by the end of the sophomore year.

<table>
<thead>
<tr>
<th>Mathematics and Statistics Prerequisites</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-111 and 21-112 Calculus I and Calculus II</td>
<td>10-20</td>
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<tr>
<td>or 21-120 Differential and Integral Calculus</td>
<td></td>
</tr>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
</tbody>
</table>

Curriculum

Core Courses

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-202 Statistical Methods</td>
</tr>
<tr>
<td>88-104 Decision Processes in American Political Institutions</td>
</tr>
</tbody>
</table>
### Language Requirement

Students are required to complete the intermediate (200) level or the equivalent in a modern language other than English. Advanced level study is strongly encouraged.

#### Electives

**45 units**

**International Relations and Politics students will either:**

**Option 1** Take 45 units (five courses) from the following categories:

- International Political Economy, International Politics and Grand Strategy, and International Cultures. Students must take at least one course from each category, with no more than two courses from any given category.
- At least two of these courses (18 units) must be from the Department of Social and Decision Sciences (88-xxx).
- Most courses listed below are 9-unit courses, but some are fewer. When courses offered for fewer than 9 units are chosen, students should note that a minimum of 45 units is required, and should plan to take one or more additional courses as appropriate.

**OR**

**Option 2** Complete all (or the majority) of their electives via the Washington Semester Program (CMUWSP) Public Policy elective sequence (45 units):

- Any elective units not fulfilled during CMUWSP may be completed through coursework from the International Political Economy, International Politics and Grand Strategy, and International Cultures elective lists.

The Washington Semester Program (CMUWSP) Public Policy Elective Sequence includes:

- **Academic Seminar** (27 units)
- **Internship and Internship Class** (9 units)
- **Research Seminar** (9 units)

### International Political Economy

- **70-365** International Trade and International Law 9
- **70-430** International Management 9
- **73-328** Health Economics 12
- **73-331** Political Economy of Inequality and Redistribution 9
- **73-371** International Trade and Economic Development 9
- **73-372** International Money and Finance 9
- **73-375** History of Money and Monetary Policy 9
- **73-394** Development Economics 9
- **79-296/80-447** Special Topics: Global Justice 9
- **79-386** Entrepreneurs in Africa, Past, Present and Future 9
- **80-136** Social Structure, Public Policy & Ethics 9
- **80-244** Environmental Ethics 9
- **80-247** Ethics and Global Economics 9
- **80-344** Management, Environment, and Ethics 9
- **80-348** Health Development and Human Rights 9
- **88-352** Environmental Economics and Policy 9
- **88-368** Conflict, Human Rights and Development 9
- **88-378** International Economics 9
- **88-391** Technology and Economic Growth 9
- **88-408** Attitudes the Media and Conflict in International Relations 9
- **88-411** The Rise of the Asian Economies 9
- **88-412** Economics of Global Warming 9
- **88-413** Energy and Climate: History, Science, Technology, & Policy in the US 1776-2016 9
- **88-419** Negotiation 9
- **88-423** Institutions, Entrepreneurship, and Innovation 9

### International Politics and Grand Strategy

- **19-609** Public Policy and Regulation 9
- **19-662** Special Topics: Technology and Development in China & India 9
- **24-484** Decision Tools for Engineering Design and Entrepreneurship 12
- **79-231** American Foreign Policy 1945-Present 9
- **80-135** Introduction to Political Philosophy 9
- **80-235** Political Philosophy 9
- **80-321** Causation, Law, and Social Policy 9
- **80-335** Deliberative Democracy: Theory and Practice 9
- **88-223** Decision Analysis and Decision Support Systems 9
- **88-302** Behavioral Decision Making 9
- **88-314** Politics through Film 9
- **88-336** Authoritas and Democrats 9
- **88-349** War and Peace 9
- **88-357** Comparative Foreign Policy: China, Russia, and the US 9
- **88-359** Globalization 9
- **88-362** Diplomacy and Statecraft 9
- **88-370** African Politics 9

### International Cultures

- **88-380** Grand Strategy in the United States 9
- **88-384** Conflict and Conflict Resolution in International Relations 9
- **88-388** Psychological Models of Decision Making 9
- **88-389** Terrorism and Insurgency 9
- **88-405** Risk Perception and Communication 9
- **88-415** Global Competitiveness: Firms, Nations, and Technological Change 9
- **88-423** Institutions, Entrepreneurship, and Innovation 9
- **88-435** Analytical Methods for Complex Social Systems 9

### International Languages

- **24-484 Decision Tools for Engineering Design and Entrepreneurship 12
- **70-342** Managing Across Cultures 9
- **76-318** Communicating in the Global Marketplace 9
- **76-322** Global Masala: South Asians in the Diaspora 9
- **76-327** Special Topics in Literary and Cultural Studies 9
- **76-386** Language & Culture 9
- **79-205** 20th Century Europe 9
- **79-212** China and its Neighbors: Minorities, Conquerors and Tribute Bearers 9
- **79-213** Nationalities and the New States of the Former USSR 9
- **79-220** Caribbean: Cultures and Histories 9
- **79-221** Development and Democracy in Latin America 9
- **79-222** Between Revolutions: The Development of Modern Latin America 9
- **79-224** Mayan America 9
- **79-227** Introduction to African History: 1780-1944 9
- **79-229** Origins of the Arab-Israeli Conflict, 1880-1948 9
- **79-230** Arab-Israeli Conflict and Peace Process since 1948 9
- **79-233** The United States and the Middle East since 1945 9
- **79-235** Caribbean Cultures 9
- **79-236** Introduction to African Studies 9
- **79-251** India/America: Democracy, Diversity, Development 9
- **79-255** Irish History 9
- **79-256** 20th Century Germany 9
- **79-257** Germany and the Second World War 9
- **79-259** France During World War II 9
- **79-261** Chinese Culture and Society 9
- **79-262** Modern China 9
- **79-263** China’s Cultural Revolution 6
- **79-264** China in the Age of Reform, 1788-Present 6
- **79-265** Russian History: From the First to the Last Tsar 9
- **79-266** Russian History: From Communism to Capitalism 9
- **79-267** The Soviet Union in World War II: Military, Political and Social History 9
- **79-275** Introduction to Global Studies 9
- **79-280** Experiencing Globalization 9
- **79-282** Europe and the World 9
- **79-286** Gandhi and King: Nonviolent Leadership in a Globalized World 9
- **79-288** Bananas, Baseball, and Borders: A History of Latin America - US Relations 9
- **79-290** States/Stateless Societies and Nationalism in West Africa 6
- **79-291** Globalization in East African History 6
- **79-292** China Inside Out: Going Global, 19th to 21st Centuries 9
- **79-299** Trafficking Persons: Children in a Global Context 9
- **79-307** Religion and Politics in the Middle East 9
- **79-309** 20th Century China Through Film 9
- **79-312** International Human Rights Institutions in Theory and Practice 9
- **79-314** The Politics and Culture of Memory 9
- **79-334** Law, Ethics, and the Life Sciences 9
- **79-342** Introduction to Science and Technology Studies 9
- **79-368** Poverty, Charity, and Welfare 9
- **79-375** China’s Environmental Crisis 9
- **79-377** Food, Culture, and Power: A History of Eating 9
- **79-381** Energy, Environment, Globalization in the Americas 9
- **79-383** Epidemic Disease and Public Health 9
- **79-385** The Making of the African Diaspora 9
- **79-392** History of Modern Warfare 9
- **79-399** Documenting the 1967 Arab-Israeli War 9
- **79-400** US-Arab Encounters 9
- **82-441** Introduction to Hispanic Literary and Cultural Studies 9
- **82-451** Studies in Latin American Literature and Culture 9
- **82-455** Latin America: Language and Culture 9
- **82-460** Francophone Realities: Africa 9
- **82-466** Francophone Realities: Francophone Realities 9
- **82-471** Special Topics: Francophone Literatures 9
- **82-491** Studies in Latin American Literature and Culture 9
- **82-494** Special Topics: Francophone Literatures 9
- **82-501** Special Topics: Hispanic Studies 9
- **83-375** Crosscultural Psychology 9
NOTE: Some courses have additional prerequisites.

International Relations and Politics, B.S.

These sample curricula represent a plan for completing the requirements for the B.S. in International Relations and Politics. International Relations and Politics students are encouraged to spend a semester studying and interning in Washington, DC, through the CMU WSP (http://www.cmu.edu/ir/academic-programs/washington-semester-program), and/or study abroad. The plan below demonstrates that a semester off-campus fits well into the curriculum. As with most majors in the Dietrich College, the International Relations and Politics major can be completed in as few as two years of undergraduate study, not that it must be. Students may declare the B.S. in International Relations and Politics and take appropriate courses as early as the second semester of the freshman year and as late as the junior year, and should consult frequently with the academic advisor (see above) about their course of study.

**Freshman**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>76-101 Interpretation and Argument</td>
</tr>
<tr>
<td>79-104 Global Histories</td>
<td>88-326 Theories of International Relations</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus*</td>
<td>IRP Elective</td>
</tr>
<tr>
<td>88-104 Decision Processes in American Political Institutions**</td>
<td>IRP Elective</td>
</tr>
</tbody>
</table>

*If required to start with 21-111 in fall of freshman year, complete 21-112 in spring of freshman year.

**This course should be taken as the first course in the International Relations and Politics major sequence. It is intended for students in their first or second years.

**Junior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-251 Empirical Research Methods</td>
<td>CMU WSP or STUDY 66-501 H&amp;SS</td>
</tr>
<tr>
<td>IRP Elective</td>
<td>IRP Elective</td>
</tr>
<tr>
<td>Language Course or Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

*All students are strongly encouraged to participate in the CMU WSP (http://www.cmu.edu/ir/wash-dc-semester-program.html) and/or in a study abroad program. Spring semester of the junior year is a popular semester to study off-campus. However, International Relations and Politics majors may instead choose to participate in the CMU WSP or study abroad in spring of sophomore year, fall of junior year, or fall of senior year. Students should consult the academic advisor when planning their curricular program.

**Students are not required to complete a college honors thesis. However, many International Relations and Politics majors choose to apply for the B.A. or B.S. in International Relations and Politics, B.S. The major must fulfill all of the requirements of the International Relations and Politics major.

**Additional Major**

Students who elect International Relations and Politics as an additional major must fulfill all of the requirements of the International Relations and Politics major.

Students pursuing Decision Science or Policy and Management with an additional major in International Relations and Politics may only count 36-202, 88-220, and 88-251 toward the completion of both majors. Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor.

The Major in Policy and Management

Paul Fischbeck, Director

Office: Porter Hall 208F
Connie Angermeier, Academic Advisor

The Policy and Management major prepares students for key decision-making and management roles in government, non-profit organizations, and business. The major emphasizes analytic approaches to decision making and practical management skills necessary for graduates to excel in both the public and private sectors. The multidisciplinary curriculum merges frontier knowledge on both the ideals of decision making, policy, and organization, as well as the realities of individual and organizational behavior that must be confronted if high-quality outcomes are going to be attained.

The major is comprised of four clusters of courses. The Analytic Methods requirement consists of four courses that provide theoretical training and practical experience in problem solving and decision making. These courses provide systematic methods for dealing with the complexities that make decisions difficult, ranging from incorporating issues of risk and uncertainty in decision making to dealing with choices that have mutually conflicting objectives. For example, a business or government agency may need to decide on a policy for mitigating the uncertain impacts of air pollution while simultaneously trying to minimize the costs of such a policy on manufacturing. A firm might want to consider the uncertain reductions in security risks from alternative policies to protect against terrorism. In this requirement, students will gain an appreciation of the economic analysis of complex decisions, as well as the trade-off between economic and political-based decision making.

The Organizational Context requirement is a course that emphasizes the analysis of how people organize and coordinate their behavior to perform complex tasks that are beyond the capability of any single individual. The course uses a multidisciplinary approach to analyze the potential shortcomings of large organizations, such as inertia, group-think, coordination failure, and bureaucratic infighting.

The Research Methods requirement is comprised of two courses focused on key methods for collecting and analyzing data that are needed to make informed decisions. Students learn to use interviews, surveys, experiments, and econometric methods to enhance their ability to test existing, and design new, policies.

Finally, the Electives requirement consists of five courses chosen by the student, in coordination with the Academic Advisor, to add depth and breadth to the major. These courses are chosen from five categories that emphasize different aspects of decision making and management: (1) policy making, (2) management, (3) technology and information, (4) international policy, and (5) political science and law. The selected courses may be from one category or from any combination of categories.

The Policy and Management major provides an excellent combination of theoretical and practical skills for students who intend to seek managerial positions. Because of its strong analytic orientation, it is also an excellent major for those who intend to go on to professional school programs in law, business, or public policy. It is also an appropriate choice for students pursuing graduate degrees in economics, political science, or decision science. One such graduate option is the accelerated masters program offered by the H. J. Heinz III School of Public Policy and Management, in which a student earns both a B.S. in Policy and Management and a M.S. in Public Policy and Management in five years.

**Prerequisites**

All Policy and Management majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

<table>
<thead>
<tr>
<th>Mathematics Prerequisites</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-111, 21-112, 21-113</td>
<td>10.20</td>
</tr>
<tr>
<td>21-120, 21-121, 21-254, 21-255</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-256, 21-257</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-258</td>
<td>Multivariate Analysis</td>
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</table>

Statistics Prerequisite

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>36-201</td>
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<table>
<thead>
<tr>
<th>Curriculum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>111 units</td>
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<table>
<thead>
<tr>
<th>Analytical Methods</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-220</td>
<td>Policy Analysis I</td>
</tr>
<tr>
<td>88-221</td>
<td>Policy Analysis II</td>
</tr>
<tr>
<td>88-223</td>
<td>Decision Analysis and Decision Support Systems</td>
</tr>
<tr>
<td>88-451</td>
<td>Policy Analysis Senior Project</td>
</tr>
<tr>
<td>88-452</td>
<td>Policy Analysis Senior Project</td>
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</tbody>
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Email: cla2@andrew.cmu.edu
Organizational Context

<table>
<thead>
<tr>
<th>Units</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>88-260 Organizations</td>
</tr>
</tbody>
</table>

Research Methods

<table>
<thead>
<tr>
<th>Units</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>36-202 Statistical Methods</td>
</tr>
<tr>
<td>9</td>
<td>88-251 Empirical Research Methods</td>
</tr>
</tbody>
</table>

Electives: 45 units

Complete at least 45 units (a minimum of five courses) from the following categories of courses. Most courses listed below are 9-unit courses, but some are less. When courses offered for less than 9 units are chosen, students should note that a minimum of 45 units is required, and should plan to take one or more additional courses as appropriate. The categories were created only to help in your selection process. You may select courses from one category or from any combination of categories.

At least 27 units (a minimum of three courses) must be Social and Decision Sciences courses (88-xxx). Some courses have additional prerequisites. At least five units must be from the following courses:

- 88-411 The Rise of the Asian Economies
- 88-412 Economics of Global Warming

5. Political Science and Law

<table>
<thead>
<tr>
<th>Units</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>70-364 Business Law</td>
</tr>
<tr>
<td>9</td>
<td>70-365 International Trade and International Law</td>
</tr>
<tr>
<td>9</td>
<td>73-408 Law and Economics</td>
</tr>
<tr>
<td>9</td>
<td>79-334 Law, Ethics, and the Life Sciences</td>
</tr>
<tr>
<td>9</td>
<td>80-235 Political Philosophy</td>
</tr>
<tr>
<td>9</td>
<td>80-321 Causation, Law, and Social Policy</td>
</tr>
<tr>
<td>9</td>
<td>88-181 Topics in Law 1st Amendment</td>
</tr>
<tr>
<td>9</td>
<td>88-184 Topics of Law: The Bill of Rights</td>
</tr>
<tr>
<td>9</td>
<td>88-389 Terrorism and Insurgency</td>
</tr>
<tr>
<td>9</td>
<td>88-444 Public Policy and Regulation</td>
</tr>
</tbody>
</table>

* only one course (either 88-181 or 88-184) may count toward an elective requirement in the Policy and Management major.

**NOTE:** Some courses have additional prerequisites.

### Policy and Management, B.S. Sample Curriculum

#### Freshman or Sophomore Year

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-220</td>
<td>Policy Analysis I</td>
</tr>
</tbody>
</table>

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-221</td>
<td>Policy Analysis II</td>
</tr>
</tbody>
</table>

**Open Prerequisite**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-251</td>
<td>Empirical Research Methods</td>
</tr>
<tr>
<td>88-220, 88-223</td>
<td>Decision Analysis and Decision Support Systems</td>
</tr>
</tbody>
</table>

**Senior Year**

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-452</td>
<td>Policy Analysis Senior Project</td>
</tr>
</tbody>
</table>

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-451</td>
<td>Policy Analysis Senior Project</td>
</tr>
</tbody>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-306</td>
<td>International Relations and Politics</td>
</tr>
</tbody>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-389</td>
<td>Diplomacy and Statecraft</td>
</tr>
</tbody>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-389</td>
<td>Conflict, Human Rights and Development</td>
</tr>
</tbody>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-389</td>
<td>African Politics</td>
</tr>
</tbody>
</table>

**Policy and Management Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-389</td>
<td>Conflict and Conflict Resolution in International Relations</td>
</tr>
<tr>
<td>88-408</td>
<td>Attitudes the Media and Conflict in International Relations</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program. Students who are planning to study abroad or to apply for the Heinz Accelerated Masters Program will have a very different curriculum map and should consult early and often with the Academic Advisor.

### Additional Major

Students who elect Policy and Management as an additional major must fulfill all of the requirements of the Policy and Management major.

Students pursuing Decision Science with an additional major in Policy and Management may only count 36-202, 88-220, 88-223, and 88-251 toward the completion of both majors.

Students pursuing International Relations and Politics with an additional major in Policy and Management may only count 36-202, 88-220, and 88-251 toward the completion of both majors.

Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor. Students who are interested in an additional major in Policy and Management should see the Academic Advisor of the Policy and Management program.

### The Minor in Policy and Management

Paul Fischbeck, Faculty Director
Office: Porter Hall 208F
Connie Angermeier, Academic Advisor
Office: Porter Hall 208A

Regardless of major, many Carnegie Mellon graduates will face managerial challenges and responsibilities in their professional lives. Whether these are in their area of expertise or in more general settings, these roles will require some degree require assumption of the responsibility for directing the work of others. The Policy and Management minor is intended for students who
expect to need these management concepts and skills. At most, one course may be double-counted with another major or minor.

Curriculum

Required Courses 36 units
88-220 Policy Analysis I 9
88-221 Policy Analysis II 9
88-223 Decision Analysis and Decision Support Systems 9
88-260 Organizations 9

Electives 18 units

Complete two courses from the following categories. At least one of the courses (9 units) must be a Social and Decision Sciences course (88-xxx).

1. Policy Making Units
36-303 Sampling, Survey and Society 9
73-328 Health Economics 12
73-331 Political Economy of Inequality and Redistribution 9
73-340 Labor Economics 9
73-352 Public Economics 9
73-357 Regulation: Theory and Policy 9
73-420 Monetary Theory and Policy 9
73-305 Juvenile Delinquency: Images, Realities; Public Policy, 1800-1967 9
73-306 Delinquency, Crime, and Juvenile justice: 1970s to the Present 9
79-338 Education and Social Reform 9
79-335 Drug Use and Drug Policy 9
79-374 American Environmental History; Critical Issues 9
80-321 Causation, Law, and Social Policy 9
88-352 Environmental Economics and Policy 9
88-365 Behavioral Economics and Public Policy 9
88-412 Economics of Global Warming 9
88-423 Institutions, Entrepreneurship, and Innovation 9
88-435 Analytical Methods for Complex Social Systems 9

2. Management Units
70-321 Negotiation and Conflict Resolution 9
70-332 Business, Society and Ethics 9
70-342 Managing Across Cultures 9
70-430 International Management 9
80-241 Ethical Judgments in Professional Life 9
80-243 Business Ethics 6
80-244 Environmental Ethics 9
88-344 Management, Environment, and Ethics 9
88-252 Empirical Research for Social Science and Policy 9
88-341 Organizational Communication 9
88-360 Behavioral Economics 9
88-363 Behavioral Economics Theory 9
88-387 Social Norms and Economics 9
88-402 Modeling Complex Social Systems 9
88-403 Network and Social Systems 9
88-419 Negotiation 9

3. Technology and Information Units
19-402 Telecommunications, Technology Policy & Management 12
19-448 Science, Technology & Ethics 9
73-414 The Economics of Ideas: Growth, Innovation and Intellectual Property 9
79-230 Arab-Israeli Conflict and Peace Process since 1948 9
79-342 Introduction to Science and Technology Studies 9
80-341 Computers, Society and Ethics 9
88-345 Perspectives on Industrial Research and Development 9
88-347 Complex Technological Systems: Past, Present, and Future 9
88-371 Entrepreneurship, Regulation and Technological Change 9
88-391 Technology and Economic Growth 9
88-415 Global Competitiveness: Firms Nations, and Technological Change 9

4. International Policy Units
79-278 Rights to Representation: Indigenous People and their Media 9
79-280 Experiencing Globalization 9
80-247 Ethics and Global Economics 9
80-447 Global Justice 9
88-362 Diplomacy and Statecraft 9
88-368 Conflict, Human Rights and Development 9
88-370 African Politics 9
88-384 Conflict and Conflict Resolution in International Relations 9
88-408 Attitudes the Media and Conflict in International Relations 9
88-411 The Rise of the Asian Economies 9
88-412 Economics of Global Warming 9

5. Political Science and Law Units
70-364 Business Law 9
70-365 International Trade and International Law 9
73-408 Law and Economics 9
79-334 Law, Ethics, and the Life Sciences 9
80-235 Political Philosophy 9
80-321 Causation, Law, and Social Policy 9
88-181 Topics in Law: 1st Amendment 9
or 88-184 Topics in Law: The Bill of Rights 9
88-389 Terrorism and Insurgency 9
88-444 Public Policy and Regulation 9

* only one course (either 88-181 or 88-184 ) may count toward an elective requirement in the Policy and Management minor.

NOTE: Some courses have additional prerequisites.

Washington Semester Program

Kiron Skinner, Faculty Director; kskinner@andrew.cmu.edu
Emily Half, Academic Advisor; ehalf@andrew.cmu.edu; 412-268-7082, Baker Hall 606C
http://www.cmu.edu/ir/academic-programs/washington-semester-program/index.html

From embassy headquarters to non-governmental organizations, think tanks to advocacy organizations, and consulting firms to media outlets, Washington, DC, is a focal point for many international and public policy activities.

Undergraduates from any course of study who would value firsthand policy experience are invited to apply to Carnegie Mellon University’s Washington Semester Program, sponsored by the university’s Center for International Relations and Politics. In this semester-long program, students live, work, and study in Washington, DC, coming into direct contact with political, business, and community leaders and learning about the most pressing policy issues of the day.

The Center for International Relations and Politics sponsors policy events and forums in Washington for CMU students participating in the program to further enrich their experience and enhance their understanding of how Washington functions as a hub of international and public policy decision making.

Students should contact the academic advisor for more information or to discuss how the CMUWSP may fit into their curriculum.

Faculty

LINDA BABCOCK, James Mellon Walton Professor of Economics – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 1988–.
SAURABH BHARGAVA, Assistant Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2012–.
SILVIA BORZUTZKY, Teaching Professor of Political Science and International Relations – Ph.D., University of Pittsburgh; Carnegie Mellon, 2001–.
SERGUEY BRAGINSKY, Associate Professor – Ph.D., Keio University, Japan; Carnegie Mellon, 2008–.
LEE BRANTSTETTER, Associate Professor – Ph.D., Harvard University; Carnegie Mellon, 2006–.
STEPHEN BROOME, Assistant Professor – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2011–.
MINA CIKARA, Assistant Professor – Ph.D., Princeton University; Carnegie Mellon, 2012–.
JULIE DOWNS, Associate Research Professor – Ph.D., Princeton University; Carnegie Mellon, 1995–.
PAUL S. FISCHBECK, Professor of Social and Decision Sciences and Engineering and Public Policy – Ph.D., Stanford University; Carnegie Mellon, 1990–.
BARUCH FISCHHOFF, Howard Heinz University Professor of Social and Decision Sciences and of Engineering and Public Policy – Ph.D., The Hebrew University of Jerusalem; Carnegie Mellon, 1987–.
CHRISTINA FONG, Senior Research Scientist – Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 2001–.
JENDAYI FRAZER, Distinguished Service Professor – Ph.D., Stanford University; Carnegie Mellon, 1987–.
RUSSELL GOLMAN, Assistant Professor – Ph.D., The University of Michigan; Carnegie Mellon, 2010–.
CLEOTILDE GONZALEZ, Associate Research Professor of Information and Decision Sciences – Ph.D., Texas Tech University; Carnegie Mellon, 2000–.
DAVID A. HOUNSHELL, David M. Roderick Professor of Technology and Social Change – Ph.D., University of Delaware; Carnegie Mellon, 1991–.

KARIM KASSAM, Assistant Professor – Ph.D., Harvard University; Carnegie Mellon, 2010–.

STEVEN KLEPPER, Arthur Arton Hamerschlag Professor of Economics and Social Science – Ph.D., Cornell University; Carnegie Mellon, 1980–.

GEORGE F. LOEWENSTEIN, Herbert A. Simon University Professor of Economics and Psychology – Ph.D., Yale University; Carnegie Mellon, 1990–.

JOHN H. MILLER, Professor of Economics and Social Science and Department Head – Ph.D., The University of Michigan; Carnegie Mellon, 1989–.

KIRON K. SKINNER, Associate Professor of International Relations and Political Science – Ph.D., Harvard University; Carnegie Mellon, 1999–.

ERTE XIAO, Assistant Professor – Ph.D., George Mason University; Carnegie Mellon, 2008–.

Faculty by Courtesy Appointment

LINDA ARGOTE, David and Barbara Kir Professor of Organizational Behavior – Ph.D., University of Michigan; Carnegie Mellon, 1979–.

KATHLEEN M. CARLEY, Professor of Sociology – Ph.D., Harvard University; Carnegie Mellon, 1984–.

DENNIS N. EPPLE, Professor of Economics – Ph.D., Princeton University; Carnegie Mellon, 1974–.

JOSEPH B. KADANE, Leonard J. Savage University Professor of Statistics and Social Science – Ph.D., Stanford University; Carnegie Mellon, 1969–.

MARK S. KAMLET, Provost and Professor of Economics and Public Policy – Ph.D., University of California, Berkeley; Carnegie Mellon, 1978–.

SARAH B. KIESLER, Professor – Ph.D., The Ohio State University; Carnegie Mellon, 1979–.

DAVID M. KRACKHARDT, Professor of Organizations and Public Policy – Ph.D., University of California, Irvine; Carnegie Mellon, 1991–.

ROBERT E. KRAUT, Hebert A. Simon Professor of Human Computer Interaction – Ph.D., Yale University; Carnegie Mellon, 1993–.

CAREY MOREWEDGE, Assistant Professor – Ph.D., Harvard University; Carnegie Mellon, 2007–.

JOEL TARR, Richard S. Caliguiri University Professor of History and Policy – Ph.D., Northwestern University; Carnegie Mellon, 1967–.

JOACHIM VOSGERAU, Assistant Professor of Marketing – Ph.D., INSEAD, France; Carnegie Mellon, 2007–.

Emeritus Faculty

WILLIAM R. KEECH, Ph.D. University of Wisconsin-Madison; Carnegie Mellon, 1997–.
Department of Statistics

Mark J. Schervish, Department Head
Ken Pawlik, Student Program Administrator
Email: acadcoord@stat.cmu.edu
Department Office: Baker Hall 132

Uncertainty is inescapable: randomness, measurement error, deception, and incomplete or missing information complicate all our lives. Statistics is the science and art of making predictions and decisions in the face of uncertainty. Statistical issues are central to big questions in public policy, law, medicine, industry, computing, technology, finance, and science. Indeed, the tools of Statistics apply to problems in almost every area of human activity where data are collected.

Statisticians must master diverse skills in computing, mathematics, decision making, forecasting, interpretation of complicated data, and design of meaningful comparisons. Moreover, statisticians must learn to collaborate effectively with people in other fields and, in the process, to understand the substance of these other fields. For all these reasons, Statistics students are highly sought-after in the marketplace.

Recent Statistics majors at Carnegie Mellon have taken jobs at leading companies in many fields, including the National Economic Research Association, Boeing, Morgan Stanley, Deloitte, Rosetta Marketing Group, Nielsen, Proctor and Gamble, Accenture, and Goldman Sachs. Other students have taken research positions at the National Security Agency, the U.S. Census Bureau, and the Science and Technology Policy Institute or worked for Teach for America. Many of our students have also gone on to graduate study at some of the top programs in the country including Carnegie Mellon, the Wharton School at the University of Pennsylvania, Johns Hopkins, University of Michigan, Stanford University, Emory University, Yale University, Columbia University, and Georgia Tech.

The Department and Faculty

The Department of Statistics at Carnegie Mellon University is world-renowned for its contributions to statistical theory and practice. Research in the department runs the gamut from pure mathematics to the hottest frontiers of science. Current research projects are helping make fundamental advances in neuroscience, cosmology, seismology, finance, and genetics.

The faculty members are recognized around the world for their expertise and have garnered many prestigious awards and honors. (For example, three members of the faculty have been awarded the COPSS medal, the highest honor given by professional statistical societies.) At the same time, the faculty is actively involved in undergraduate education. The entire faculty, junior and senior, teaches courses at all levels, including the introductory courses. The faculty are accessible and are committed to involving undergraduates in research.

The Department augments all these strengths with a friendly, energetic working environment and exceptional computing resources. Talented graduate students join the department from around the world, and add a unique dimension to the department’s intellectual life. Faculty, graduate students, and undergraduates interact regularly.

How to Take Part

There are many ways to get involved in Statistics at Carnegie Mellon:

- The Bachelor of Science in Statistics in the College of Humanities and Social Sciences (H&SS) is a broad-based, flexible program that helps you master both the theory and practice of Statistics. The program can be tailored to prepare you for later graduate study in Statistics or to complement your interests in almost any field, including Psychology, Physics, Biology, History, Business, Information Systems, and Computer Science.
- The Minor (or Additional Major) in Statistics is a useful complement to a (primary) major in another Department or College. Almost every field of inquiry must grapple with statistical problems, and the tools of statistical theory and data analysis you will develop in the Statistics minor will give you a critical edge.
- The Bachelor of Science in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major’s curriculum provides students with a solid foundation in the theories and methods of both fields. (See H&SS Interdepartmental Majors as well as later in this section)

- The Statistical and Mathematical Sciences Program (within the Science and Humanities Scholars Program) is an alternative path for the study of Statistics that is jointly administered by the Department of Mathematical Sciences and the Department of Statistics.
- The Statistics Concentration within the Mathematical Sciences Major (see Department of Mathematical Sciences) is jointly administered by the Department of Mathematical Sciences and the Department of Statistics.
- There are several ongoing exciting research projects in the Department of Statistics, and the department enthusiastically seeks to involve undergraduates in this work. Both majors and non-majors are welcome.
- Non-majors are eligible to take most of our courses, and indeed, they are required to do so by many programs on campus. Such courses offer one way to learn more about the Department of Statistics and the field in general.

Curriculum

Statistics consists of two intertwined threads of inquiry: Statistical Theory and Data Analysis. The former uses probability theory to build and analyze mathematical models of data in order to devise methods for making effective predictions and decisions in the face of uncertainty. The latter involves techniques for extracting insights from complicated data, designs for accurate measurement and comparison, and methods for checking the validity of theoretical assumptions. Statistical Theory informs Data Analysis and vice versa. The Statistics Department curriculum follows both of these threads and helps the student develop the complementary skills required.

Below, we describe the requirements for the Major in Statistics and the different categories within our basic curriculum, followed by the requirements for the Minor in Statistics and the requirements for the Major in Economics and Statistics.

Note: We recommend that you use the information provided below as a general guideline, and then schedule a meeting with a Statistics Undergraduate Advisor (email: acadcoord@stat.cmu.edu) to discuss the requirements in more detail, and build a program that is tailored to your strengths and interests.

B.S. in Statistics

Students in the Bachelor of Science program develop and master a wide array of skills in computing, mathematics, statistical theory, and the interpretation and display of complex data. In addition, Statistics majors gain experience in applying statistical tools to real problems in other fields and learn the nuances of interdisciplinary collaboration. The requirements for the Major in Statistics are detailed below and are organized by categories #1-#6.

1. Mathematical Foundations (Prerequisites) 28-38 units

Mathematics is the language in which statistical models are described and analyzed, so some experience with basic calculus and linear algebra is an important component for anyone pursuing a program of study in Statistics.

**Calculus**: Complete one of the following three sequences of mathematics courses at Carnegie Mellon, each of which provides sufficient preparation in calculus:

**Sequence 1**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-111</td>
<td>Calculus I</td>
<td>10</td>
</tr>
<tr>
<td>21-112</td>
<td>Calculus II</td>
<td>10</td>
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and one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
</tbody>
</table>

**Sequence 2**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
</tbody>
</table>

and one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
</tbody>
</table>

**Linear Algebra**: Complete one of the following two courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Note: Other sequences are possible, and require approval from the undergraduate advisor.
2. Data Analysis: 45 units
Data analysis is the art and science of extracting insight from data. The art lies in knowing which displays or techniques will reveal the most interesting features of a complicated data set. The science lies in understanding the various techniques and the assumptions on which they rely. Both aspects require practice to master.

The Beginning Data Analysis courses give a hands-on introduction to the art and science of data analysis. The courses cover similar topics but differ slightly in the examples they emphasize. 36-201 draws examples from many fields and satisfies the H&S College Core Requirement in Statistical Reasoning. It is therefore the recommended course for students in the College. (Note: A score of 5 on the Advanced Placement (AP) Exam in Statistics may be used to waive this requirement). Other courses emphasize examples in business (36-207), engineering and architecture (36-220), and the laboratory sciences (36-247).

The Intermediate Data Analysis courses build on the principles and methods covered in the introductory course, and more fully explore specific types of data analysis methods in more depth.

The Advanced Data Analysis courses draw on students’ previous experience with data analysis and understanding of statistical theory to develop advanced, more sophisticated methods. These core courses involve extensive analysis of real data with emphasis on developing the oral and writing skills needed for communicating results.

**Beginning**
Choose one of the following courses:

- 36-201 Statistical Reasoning and Practice 9
- 36-207 Probability and Statistics for Business Applications 9
- 36-220 Engineering Statistics and Quality Control 9
- 36-247 Statistics for Lab Sciences 9
- 36-315 Linear Algebra *** 9

* Students who enter the program with 36-225 or 36-226 should discuss options with an advisor. Any 36-300 or 36-400 level course that does not qualify as a Statistical Elective.

**Intermediate**
Choose one of the following courses:

- 36-225 Introduction to Probability Theory ** 9
- 36-226 Introduction to Statistical Inference 9

* It is possible to substitute 36-217 or 32-325 for 36-225. (36-225 is the standard introduction to probability, 36-217 is tailored for engineers and computer scientists, and 21-325 is a rigorous Probability Theory course offered by the Department of Mathematics.)

Comments:
(i) In order to be a Major or a Minor in good standing, a grade of at least a C is required in 36-225, 36-226 and 36-401. In particular, a grade of C or higher is required in order to be able to continue in the major.

(ii) In special cases, and in consultation with the Statistics Advisor, the theory requirement can be satisfied by taking the graduate level class 36-625 Probability and Mathematical Statistics I, which is much more mathematically rigorous. This option should be considered by strong Statistics Majors who are also majoring in Computer Science, Operations Research, or Mathematics and/or who are considering graduate study in Statistics. This option requires special permission. Students who end up satisfying the theory requirement by taking the (single) course 36-625 are required take an additional statistics elective (see category #5, Statistical Electives, below).

4. Special Topics: 9 units
The Statistics Department offers advanced courses that focus on specific statistical applications or advanced statistical methods. These courses are numbered 36-46x (36-461, 36-462, etc.). Two of these courses will be offered every year, one per semester. Past topics included Statistical Learning, Data Mining, Statistics and the Law, Bayesian Statistics, Nonparametric Statistics, Statistical Genetics, and Statistical Methods in Epidemiology. The objective of the course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.

To satisfy the Special Topics requirement choose one of the 36-46x courses (which are 9 units).

Note: All 36-46x courses require 36-401 as a prerequisite or instructor permission.

5. Statistical Elective: 9 units
Students are required to take one* elective which can be within or outside the Statistics Department. Courses within statistics can be any 300 or 400 level course (that is not used to satisfy any other requirement for the statistics major).

The following is a partial list of courses outside statistics that qualify as electives as they provide intellectual infrastructure that will advance the student’s understanding of statistics and its applications. Other courses may qualify as well; consult with the Statistics Undergraduate Advisor.

- 15-110 Principles of Computing 10
- 15-122 Principles of Imperative Computation 10
- 21-127 Concepts of Mathematics 10
- 21-259 Calculus in Three Dimensions 9
- 21-260 Differential Equations 9
- 21-282 Operations Research I 9
- 21-301 Combinatorics 9
- 80-220 Philosophy of Science 9
- 80-221 Philosophy of Social Science 9
- 80-310 Formal Logic 9
- 85-310 Research Methods in Cognitive Psychology 9
- 88-223 Decision Analysis and Decision Support Systems 9
- 88-302 Behavioral Decision Making 9

* Students who enter the program through 36-225 or 36-226 and skip the beginning data analysis course, or students who end up satisfying the theory requirement using the (single) course 36-625, are required take two electives only one of which can be outside the Statistics Department. (In general, any waived requirement is replaced by a statistical elective.)

6. Concentration Area*: 36 units
The power of Statistics, and much of the fun, is that it can be applied to answer such a wide variety of questions in so many different fields. A critical part of statistical practice is understanding the questions being asked so that appropriate methods of analysis can be used. Hence, a critical part of statistical training is to gain experience applying the abstract tools to real problems. The Concentration Area is a set of four related courses outside of Statistics that prepares the student to deal with statistical aspects of...
problems that arise in another field. These courses are usually drawn from a single discipline of interest to the student and are chosen in consultation with the Statistics Undergraduate Advisor. For example, students intending to pursue careers in public policy could take further courses in History or Economics, students intending to pursue careers in the health or biomedical sciences could take further courses in Biology or Chemistry, and students intending to pursue graduate work in Statistics could take further courses in advanced Mathematics. * Note: This requirement is only for students whose primary major is statistics and have no other additional major or minor. The requirement does not apply for students who pursue an additional major in statistics.

**Total Number of Units for the Major:** 145*

**Total Number of Units for the Degree:**

* Note: This number can vary depending on the calculus sequence a student takes. In addition this number includes the 36 units of the "Concentration Area" category which may not be required (see category 6 above for details).

**Recommendations**

Students in the College of Humanities and Social Sciences who wish to major or minor in Statistics are advised to complete both the calculus requirement (one Mathematical Foundations calculus sequence) and the Beginning Data Analysis course 36-201 Statistical Reasoning and Practice by the end of their Freshman year.

The linear algebra requirement is a prerequisite for the course 36-401. It is therefore essential to complete this requirement during your junior year at the latest!

**Additional Major in Statistics**

Students who elect Statistics as a second or third major must fulfill all Statistics degree requirements except for the Concentration Area requirement. Majors in many other programs would naturally complement a Statistics Major, including Tepper’s undergraduate business program, Social and Decision Sciences, Policy and Management, and Psychology.

With respect to double-counting courses, it is departmental policy that students must have at least five statistics courses that do not count for their primary major. If students do not have at least five, they typically take additional advanced electives.

Students are advised to begin planning their curriculum (with appropriate advisors) as soon as possible. This is particularly true if the other major has a complex set of requirements and prerequisites or when many of the other major’s requirements overlap with the requirements for a Major in Statistics.

**Research**

One goal of the Statistics program is to give students experience with statistical research. There is a wide variety of ongoing research projects in the department, and students have several opportunities to get involved in a project that interests them.

Before graduation, students are encouraged to participate in a research project under faculty supervision. Students can do this through projects in specific courses (such as 36-303), through an independent study, or through a summer research position.

Qualified students are also encouraged to participate in an advanced research project through 36-490 Undergraduate Research or independent study under the supervision of a Statistics faculty advisor. Students who maintain a quality point average of 3.25 overall may also apply to participate in the H&SS Senior Honors Program (p. 169).

**Sample Programs**

The following sample programs illustrate two (of many) ways to satisfy the requirements of the Statistics Major. However, keep in mind that the program is flexible enough to support many other possible schedules and to emphasize a wide variety of interests.

The first schedule uses calculus sequence 1, and 21-127 Concepts of Mathematics could take further courses in Biology or Chemistry, and students intending to pursue graduate work in Statistics could take further courses in advanced Mathematics.

The second schedule is an example of the case when a student enters the program through 21-225 and 21-226 (and therefore skips the beginning data analysis course). The schedule uses calculus sequence 2, and includes two electives (36-315 and 36-410), both within the Statistics Department. This schedule has more emphasis on statistical theory and probability.

In both schedules, C.A. refers to Concentration Area courses.

### Schedule 1

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>36-202 Statistical Methods</td>
<td></td>
</tr>
<tr>
<td>21-111 Calculus I</td>
<td>21-112 Calculus II</td>
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</table>

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>36-315 Statistical Graphics and Visualization</td>
<td></td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Junior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>36-226 Introduction to Statistical Inference</td>
<td></td>
</tr>
<tr>
<td>C.A.</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-401 Modern Regression</td>
<td>36-402 Advanced Data Analysis</td>
<td></td>
</tr>
<tr>
<td>C.A.</td>
<td>36-46x Special Topics</td>
<td></td>
</tr>
</tbody>
</table>

### Schedule 2

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>21-256 Multivariate Analysis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>36-226 Introduction to Statistical Inference</td>
<td></td>
</tr>
<tr>
<td>36-309 Experimental Design for Behavioral and Social Sciences</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Junior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-350 Statistical Computing</td>
<td>36-315 Statistical Graphics and Visualization</td>
<td></td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.A.</td>
<td>36-402 Advanced Data Analysis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-402 Advanced Data Analysis</td>
<td>36-46x Special Topics</td>
<td></td>
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<tr>
<td>C.A.</td>
<td></td>
<td></td>
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</tbody>
</table>

### The Major in Economics and Statistics

**Faculty Advisor:** Rebecca Nugent  
**Office:** Baker Hall 132A  
**Email:** acadcoord@stat.cmu.edu

The major in economics and statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Economics Department, the major’s curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics.

Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

The requirements for the B.S. in Economics and Statistics are the following:

### I. Prerequisites 66/76 units

**Course List**

#### 1. Mathematical Foundations 39 units

<table>
<thead>
<tr>
<th>21-120</th>
<th>Differential and Integral Calculus</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
</tr>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
</tr>
<tr>
<td>36-202</td>
<td>Statistical Methods</td>
</tr>
</tbody>
</table>

#### 2. Economics Foundations 9 units

| 73-100 | Principles of Economics |

#### 3. Statistical Foundations 18 units

**Course List**
The Minor in Statistics

The Minor in Statistics develops skills that complement major study in other disciplines. The program helps the student master the basics of statistical theory and advanced techniques in data analysis. This is a good choice for deepening understanding of statistical ideas and for strengthening research skills.

In order to get a minor in Statistics a student must satisfy all the requirements in categories 1, 2 and 3 of the major requirement (see above) and the exception that in the advanced data analysis part only 36-401 and 36-402 are required. In other words, the requirements for the minor are listed below. The following two sample programs illustrates two (of many) ways to satisfy the requirements of the Minor in Statistics:

1. Mathematical Foundations (Prerequisites) 28-38 units
   Identical to Major requirements (read relevant section above carefully).

2. Data Analysis: 36 units
   Beginning Data Analysis: 9 units (one course) - see Major requirements above.
   Intermediate Data Analysis: 9 units (one course) - see Major requirements above.
   Advanced Data Analysis: 18 units - 36-401 and 36-402

3. Probability Theory and Statistical Theory: 18 units
   Identical to Major requirements (read relevant section above carefully).

**Total number of units required for** 82 Units **the minor**

With respect to double-counting courses, it is departmental policy that students must have at least three statistics courses that do not count for their primary major. If students do not have at least three, they typically take additional advanced electives.

Sample Programs for the Minor

The following two sample programs illustrates two (of many) ways to satisfy the requirements of the Statistics Minor. Keep in mind that the program is flexible and can support many other possible schedules.

The first schedule uses calculus sequence 1, and 36-309 to satisfy the intermediate data analysis requirement. The second schedule is an example of the case when a student enters the Minor through 36-225 and 36-226 (and therefore skips the beginning data analysis course). The schedule uses calculus sequence 2, and 36-315 as an elective (to replace the beginning data analysis course).

### Schedule 1

<table>
<thead>
<tr>
<th>Freshman Fall</th>
<th>Sophomore Fall</th>
<th>Senior Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>36-208 Regression Analysis</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>36-309 Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>73-252 Advanced Microeconomic Theory</td>
<td>6</td>
<td></td>
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<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>73-253 Advanced Macroeconomic Theory</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>73-270 Writing for Economists</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>73-363 Econometrics</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

*In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

### Schedule 2

<table>
<thead>
<tr>
<th>Freshman Fall</th>
<th>Sophomore Fall</th>
<th>Senior Fall</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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</tbody>
</table>

*In order to be a major in good standing, a grade of C or better is required in 36-225 (or equivalents), 36-226 and 36-401. Otherwise you will not be allowed to continue in the major.

Advanced Electives 45 units

Students must take two advanced economics elective courses (numbered 73-300 through 73-495) and two advanced statistics elective courses (numbered 36-300 through 36-405). A fifth advanced elective is required and can be chosen from either statistics or economics.

**Total number of units for the major 195 units**

Total number of units for the degree 360 units

Sample Program

The following sample program illustrates one way to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see footnotes below the schedule).

<table>
<thead>
<tr>
<th>Freshman</th>
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<th>Senior</th>
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<tbody>
<tr>
<td>Fall</td>
<td>Fall</td>
<td>Fall</td>
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<tr>
<td>21-111 Calculus I</td>
<td>21-112 Calculus II</td>
<td>21-256 Multivariate Analysis</td>
</tr>
<tr>
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<td>21-112 Calculus II</td>
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<tr>
<td>21-111 Calculus I</td>
<td>21-112 Calculus II</td>
<td>21-256 Multivariate Analysis</td>
</tr>
</tbody>
</table>

Students who elect Statistics as a second major must fulfill all Statistics degree requirements. However, the Concentration Area requirement is usually waived in consultation with the student’s advisor. Majors in many other programs would naturally complement a Statistics Major, including GSA’s undergraduate business program, Social and Decision Sciences, Policy and Management, History and Policy, and Psychology.

With respect to double-counting courses, it is departmental policy that students must have at least five statistics courses that do not count for their primary major. If students do not have at least five, they typically take additional advanced electives.

Students are advised to begin planning their curriculum (with appropriate advisors) as soon as possible. This is particularly true if the other major has a complex set of requirements and prerequisites.

**Mini Courses**

Sample Programs for the Minor

**Total number of units required for** 82 Units **the minor**

With respect to double-counting courses, it is departmental policy that students must have at least three statistics courses that do not count for their primary major. If students do not have at least three, they typically take additional advanced electives.

Sample Programs for the Minor

The following two sample programs illustrates two (of many) ways to satisfy the requirements of the Statistics Minor. Keep in mind that the program is flexible and can support many other possible schedules.

The first schedule uses calculus sequence 1, and 36-309 to satisfy the intermediate data analysis requirement. The second schedule is an example of the case when a student enters the Minor through 36-225 and 36-226 (and therefore skips the beginning data analysis course). The schedule uses calculus sequence 2, and 36-315 as an elective (to replace the beginning data analysis course).
Substitutions and Waivers

Many departments require Statistics courses as part of their Major or Minor programs. Students seeking transfer credit for those requirements from substitute courses (at Carnegie Mellon or elsewhere) should seek permission from their advisor in the department setting the requirement. The final authority in such decisions rests there. The Statistics Department does not provide approval or permission for substitution or waiver of another department’s requirements.

However, the Statistics Director of Undergraduate Studies will provide advice and information to the student’s advisor about the viability of a proposed substitution. Students should make available as much information as possible concerning proposed substitutions. Students seeking waivers may be asked to demonstrate mastery of the material.

Statistics Majors and Minors seeking substitutions or waivers should speak to the Statistics Director of Undergraduate Studies.

Faculty

STEPHEN E. FIENBERG, University Professor and Maurice Falk Professor of Statistics and Social Sciences – Ph.D., Harvard University; Carnegie Mellon, 1980–.

CHRISTOPHER GENOVESE, Professor of Statistics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1994–.

JOEL B. GREENHOUSE, Professor of Statistics – Ph.D., University of Michigan; Carnegie Mellon, 1982–.

JIASHUN JIN, Associate Professor – Ph.D., Stanford University; Carnegie Mellon, 2007–.

BRIAN JUNKER, Professor of Statistics – Ph.D., University of Illinois; Carnegie Mellon, 2007–.

ROBERT E. KASS, Professor of Statistics – Ph.D., University of Chicago; Carnegie Mellon, 1981–.

ANN LEE, Associate Professor – Ph.D., Brown University; Carnegie Mellon, 2005–.

JOHN P. LEHOCZKY, Thomas Lord Professor of Statistics and Dean of the College of Humanities and Social Sciences – Ph.D., Stanford University; Carnegie Mellon, 1969–.

JING LEI, Assistant Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2011–.

REBECCA NUGENT, Associate Teaching Professor – Ph.D., University of Washington; Carnegie Mellon, 2006–.

ALESSANDRO RINALDO, Associate Professor – Ph.D., Carnegie Mellon; Carnegie Mellon, 2005–.

KATHRYN ROEDER, Professor of Statistics – Ph.D., Pennsylvania State University; Carnegie Mellon, 1994–.

CHAD M. SCHAFER, Associate Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–.

MARK J. SCHERVISH, Department Head and Professor of Statistics – Ph.D., University of Illinois; Carnegie Mellon, 1979–.

TEDDY SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics – Ph.D., Columbia University; Carnegie Mellon, 1985–.

COSMA SHALIZI, Associate Professor – Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2005–.

RYAN TIBSHIRANI, Assistant Professor – Ph.D., Stanford University; Carnegie Mellon, 2011–.

VALERIE VENTURA, Associate Professor – Ph.D., University of Oxford; Carnegie Mellon, 1997–.

LARRY WASSERMAN, Professor of Statistics – Ph.D., University of Toronto; Carnegie Mellon, 1988–.

Emeriti Faculty

GEORGE T. DUNCAN, Professor of Statistics and Public Policy – Ph.D., University of Minnesota; Carnegie Mellon, 1974–.

WILLIAM F. EDDY, John C. Warner Professor of Statistics – Ph.D, Yale University; Carnegie Mellon, 1976–.

JOSEPH B. KADANE, Leonard J. Savage Professor of Statistics and Social Sciences – Ph.D., Stanford University; Carnegie Mellon, 1969–.

Adjunct Faculty

ANTHONY BROCKWELL, – Ph.D., Melbourne University; Carnegie Mellon, 1999–.

BERNIE DEVLIN, – Ph.D., Pennsylvania State University; Carnegie Mellon, 1994–.

Visiting Faculty

JESSI CISEWSKI, Visiting Assistant Professor – Ph.D., University of North Carolina; Carnegie Mellon, 2012–.

MICHAEL FINEGOLD, Visiting Assistant Professor – Ph.D., University of Chicago; Carnegie Mellon, 2010–.

TRENT GAUGLER, Visiting Assistant Professor – Ph.D., Pennsylvania State University; Carnegie Mellon, 2011–.

REBECCA CARTER STEORTS, Visiting Assistant Professor – Ph.D., University of Florida; Carnegie Mellon, 2012–.

DREW THOMAS, Visiting Assistant Professor – Ph.D., Harvard; Carnegie Mellon, 2009–.

Special Faculty

PETER FREEMAN, Research Associate – Ph.D., University of Chicago; Carnegie Mellon, 2004–.

HOWARD SELTMAN, Senior Research Statistician – Ph.D., Carnegie Mellon; M.D., Medical College of Pennsylvania; Carnegie Mellon, 1999–.

ISABELLA VERDINELLI, Professor in Residence – Ph.D., Carnegie Mellon, 2011–.

TEDDY SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics – Ph.D., Columbia University; Carnegie Mellon, 1985–.

LARRY WASSERMAN, Professor of Statistics – Ph.D., University of Toronto; Carnegie Mellon, 1988–.

COSMA SHALIZI, Associate Professor – Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2005–.

MARK J. SCHERVISH, Department Head and Professor of Statistics – Ph.D., University of Illinois; Carnegie Mellon, 1979–.

CHAD M. SCHAFER, Associate Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–.
H. John Heinz III College

Ramayya Krishnan, Dean
Office: 1509 Hamburg Hall
http://www.heinz.cmu.edu/

What draws students to the graduate programs of Carnegie Mellon University’s H. John Heinz III College? Students entering Heinz College are accomplished, talented and committed to important issues of public interest. At this school, each student gains the skills and knowledge necessary to transform that talent and commitment into a successful career and a positive force for change.

Heinz College is a dynamic community of scholars and practitioners developing fundamental knowledge about and seeking innovative, applied solutions to today’s most critical problems of public policy, information systems and management. The degree programs offered at Heinz College are:

- Master of Science in Public Policy and Management (options include joint and dual degree programs with the Tepper School of Business, a dual degree program with the University of Pittsburgh School of Law and a track that includes one year of study at the main campus in Pittsburgh and one year of study/experiential learning at our location in Washington, DC)
- Master of Arts Management
- Master of Entertainment Industry Management
- Master of Science in Health Care Policy and Management
- Master of Medical Management
- Master of Public Management
- Master of Science in Biotechnology and Management
- Master of Information Systems Management
- Master of Science in Information Security Policy and Management
- Doctor of Philosophy in Public Policy and Management
- Doctor of Philosophy in Information Systems

Distinctive features of Heinz College include the quality of its research and teaching, and the attention it gives to the needs of its students. Heinz College’s educational environment offers:

- An innovative curriculum incorporating analytic rigor; depth of substantive knowledge; applied project work; marketable and transferable skill development; and the integration of policy, technology and management.
- Daily access to faculty members known internationally for expertise in their fields.
- Exposure to cutting-edge technologies and management practices geared toward the needs of the changing organizations pursuing the public interest.
- The flexibility to adapt to the specific interests and career aspirations of students.
- Support for diversity and individual student needs.

Heinz College programs vary by structure, yet they share a common goal - preparing students for professional positions in which they can help to improve society and the organizations that comprise it.

How is Heinz College different?

Diversity

Heinz College’s student body is internationally recognized for its diversity in ethnicity, gender and citizenship. It also is diverse in terms of students’ academic backgrounds, which include undergraduate degrees in architecture, biology, business administration, computer science, economics, education, engineering, English, fine arts, government, history, information systems, philosophy, political science, sociology and many other fields.

Practical Experience

Heinz College doesn’t just teach skills in the classroom. Students work in teams to analyze and develop solutions for current international, national and local problems and present their findings to the officials who have responsibility for addressing those problems. Students take a paid summer internship to practice the skills they’ve learned in school.

Impact on Society

The expertise of a renowned faculty is transferred to society through the education and research mission of Heinz College, as well as the efforts of its policy and research centers. These include the National Consortium on Violence Research, Institute for the Study of Information Technology and Society, the Center for Economic Development, the Arts and Culture Observatory and the Center for Technology in the Arts. Heinz College students can work on projects initiated in these centers or as research assistants for center faculty.

Options for Carnegie Mellon Undergraduates

Heinz College does not offer undergraduate degrees. It does offer two study options, however, for students pursuing Carnegie Mellon undergraduate degrees - 1) Accelerated Master’s Program (AMP), and 2) undergraduate minor in Health Care Policy and Management.

Five-Year Masters Program

Heinz College’s Accelerated Masters Program (AMP) allows qualified students to earn a prestigious master’s degree in just five years.

- The Master of Science in Public Policy and Management and Master of Science in Health Care Policy and Management programs are open to students from all undergraduate degree programs at the university.
- The Master of Science in Biotechnology Management requires a science or engineering background.
- For students in the College of Fine Arts or the Bachelor of Humanities and Arts degree program who are interested in careers in arts management, Heinz College offers an accelerated track in the Master of Arts Management degree.
- For students with a business and/or IT background, the Master of Information Systems Management degree can be completed in just one additional semester of study beyond their bachelor’s degrees.

Additional information can be found on our website: http://www.heinz.cmu.edu.

Minor in Health Care Policy and Management

Sponsored by:
H. John Heinz III College
Dietrich College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:
Caroline Acker, Dietrich College of Humanities and Social Sciences
Patti Lee, H. John Heinz III College
Justin Crowley, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum 60 units minimum

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100 Principles of Economics or 88-220 Policy Analysis I or the equivalent by approval.

Required Courses 39 units

Students are required to take the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-330</td>
<td>Medicine and Society</td>
<td>9</td>
</tr>
<tr>
<td>90-636</td>
<td>Health Systems</td>
<td>6</td>
</tr>
<tr>
<td>90-862</td>
<td>Health Policy</td>
<td>6</td>
</tr>
<tr>
<td>94-705</td>
<td>Health Economics</td>
<td>12</td>
</tr>
</tbody>
</table>
27 units

Elective Courses
Complete a minimum of 27 units.

Heinz College Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-708</td>
<td>Healthcare Ethics</td>
<td>6</td>
</tr>
<tr>
<td>90-721</td>
<td>Healthcare Management</td>
<td>6</td>
</tr>
<tr>
<td>90-818</td>
<td>Health Care Quality &amp; Performance Improvement</td>
<td>6</td>
</tr>
<tr>
<td>90-830</td>
<td>Introduction to Financial Management of Health Care</td>
<td>6</td>
</tr>
<tr>
<td>90-831</td>
<td>Advanced Financial Management of Health Care</td>
<td>6</td>
</tr>
<tr>
<td>90-832</td>
<td>Health Law</td>
<td>12</td>
</tr>
<tr>
<td>90-863</td>
<td>Health Policy II</td>
<td>6</td>
</tr>
<tr>
<td>94-706</td>
<td>Healthcare Information Systems</td>
<td>12</td>
</tr>
</tbody>
</table>

Humanities and Social Sciences Courses (9 units each)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-494</td>
<td>Healthcare Communications</td>
<td>9</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
<td>9</td>
</tr>
<tr>
<td>79-383</td>
<td>Epidemic Disease and Public Health</td>
<td>9</td>
</tr>
<tr>
<td>80-245</td>
<td>Medical Ethics</td>
<td>9</td>
</tr>
<tr>
<td>80-247</td>
<td>Ethics and Global Economics</td>
<td>9</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-442</td>
<td>Health Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-446</td>
<td>Psychology of Gender</td>
<td>9</td>
</tr>
</tbody>
</table>

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

What kinds of careers do Heinz College graduates pursue?

A Heinz College degree opens doors to a wide range of professional careers in government agencies, nonprofit organizations, consulting firms, arts groups, foundations, private businesses and a host of other organizations. Heinz College graduates can get the kind of interesting, exciting jobs they want, because they have the expertise in policy, management, finance, information systems, and decision-making that employers need.

Heinz College’s Ph.D. program in particular prepares qualified students from a variety of academic and professional backgrounds for careers in research, academia, government-related organizations and the private sector, in positions where expertise in advanced research is desired. Graduates of the Ph.D. program work as professors, research scientists, research directors and consultants, across diverse areas of public service and management.

Some of the jobs that have been held by Heinz College graduates include:

- Budget Analyst, Congressional Budget Office
- President/Chief Executive Officer, Urban League of Philadelphia
- Vice President, Public Finance Division, Donaldson, Lufkin & Jenrette Securities Corp.
- Executive Director, Allegheny Conference on Community Development
- Executive Director, Maryland Small Business Development Financing Authority
- District Manager, AT&T Consumer Information
- Senior Consultant, Ernst and Young
- Director of Marketing, Bardavon 1869 Opera House, Poughkeepsie, NY
- Consultant, Hill Arts and Entertainment
- Special Projects Coordinator, Washington Very Special Projects
- Managing Director, Misonomer Dance Theater

The Faculty

Heinz College faculty members have been recognized nationally and internationally for their accomplishments in research and their contributions to public policy. Their backgrounds are in economics, operations research, information systems and technology, fine arts, sociology, public policy, statistics, organizational management and behavior, finance, statistics, labor relations, and demography among other areas. The the right is information on many full-time Carnegie Mellon University faculty members who teach and do research at Heinz College. For a more complete, current list, visit http://www.heinz.cmu.edu/directories/faculty-directory/index.aspx.

For further information about Heinz College, contact:
Director of Admissions
H. John Heinz III College
Carnegie Mellon University
Pittsburgh, PA 15213

Telephone: (412) 268-2164
Toll-free (U.S.): 1-800-877-3498
Fax: (412) 268-7036
Email: hnzadmit@andrew.cmu.edu
Website: http://www.heinz.cmu.edu

Faculty

ALESSANDRO ACQUISTI, Assistant Professor of Information Systems and Public Policy – Ph.D., UC Berkeley; Carnegie Mellon, 2003–.

SHAMENA ANWAR, Assistant Professor of Economics and Public Policy – Ph.D., Yale University; Carnegie Mellon, 2007–.

LINDA BABCOCK, James M. Walton Professor of Economics – Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 1988–.

EDWARD BARR, Associate Teaching Professor – M.S., Indiana University of Pennsylvania; Carnegie Mellon, 2000–.

ALFRED BLOUMSTEIN, J. Erik Jonsson University Professor of Urban Systems and Operations Research; Director, National Consortium on Violence Research – Ph.D., Cornell University; Carnegie Mellon, 1969–.

SILVIA BORZUTSKY, Associate Teaching Professor – Ph.D., University of Pittsburgh; Carnegie Mellon, 2001–.

LIRI BRANSTETTER, Associate Professor of Economics – Ph.D., Harvard University; Carnegie Mellon, 2006–.

KATHELEEN CARLEY, Professor of Organizational Sociology – Ph.D., Harvard University; Carnegie Mellon, 2011–.

JONATHAN CAULKINS, Professor of Operations Research and Public Policy; Faculty Chair, Master of Public Policy and Management Program – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1990–.

JACK CHOW, Distinguished Service Professor – M.D., University of California at San Francisco School of Medicine; Carnegie Mellon, 2011–.

KAREN CLAY, Assistant Professor of Economics and Public Policy – Ph.D., Stanford University; Carnegie Mellon, 1997–.

JACQUELINE COHEN, Principal Research Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982–.

WESLEY COHEN, (Affiliated) Professor of Economics and Social Sciences – Ph.D., Yale University; Carnegie Mellon, 1982–.

LAURA DABBISH, Assistant Professor of Information Technology and Organizations – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006–.

GEORGE T. DUNCAN, Professor of Statistics, Emeritus – Ph.D., University of Minnesota; Carnegie Mellon, 2011–.

DENNIS EPPLE, (Affiliated) Thomas Lord Professor of Economics – Ph.D., Princeton University; Carnegie Mellon, 1974–.

JENDAYI E. FRAZER, Distinguished Service Professor – Ph.D., Stanford University; Carnegie Mellon, 2011–.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy; Faculty Chair, Ph.D. Program – Ph.D., Northwestern University; Carnegie Mellon, 1995–.

WIJSN GÖRR, Professor of Public Policy and Management Information Systems – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985–.

ROBERT HAMPSHIRE, Assistant Professor of Operations Research and Public Policy – Ph.D., Princeton University; Carnegie Mellon, 2007–.

JAMES F. JORDAN, Distinguished Service Professor – M.B.A., Boston University; Carnegie Mellon, 2011–.


WILLIAM P. KITTREDGE, Associate Teaching Professor – Ph.D., Maxwell School of Public Affairs and Citizenship; Carnegie Mellon, 2011–.

STEVEN KLEPPER, (Affiliated) Professor of Economics and Social Science – Ph.D., Cornell University; Carnegie Mellon, 1980–.

DAVID KRACKHARDT, Professor of Organizations and Public Policy – Ph.D., University of California at Irvine; Carnegie Mellon, 1991–.
RAMAYYA KRISHNAN, William W. and Ruth E. Cooper Professor of Management Science and Information Systems; Faculty Chair, Master of Information Systems Management Program – Ph.D., University of Texas at Austin; Carnegie Mellon, 1987–.

KRISTIN KURLAND, Associate Teaching Professor (joint with School of Architecture) – B.A., University of Pittsburgh; Carnegie Mellon, 1999–.

LESTER LAVE, James Higgins Professor of Economics and Finance, Professor of Urban and Public Affairs, Professor of Engineering and Public Policy – Ph.D., Harvard University; Carnegie Mellon, 1963–.

GORDON LEWIS, Associate Professor of Sociology; Faculty Chair, Master of Public Policy Management Program – Ph.D., Stanford University; Carnegie Mellon, 1969–.

PAMELA LEWIS, Teaching Professor of Professional Speaking – D.A., Carnegie Mellon University; Carnegie Mellon, 1980–.

ARI LIGHTMAN, Practice Professor, Digital Media and Marketing – M.B.A., Carnegie Mellon University; Carnegie Mellon, 2011–.

PETER MADSEN, Senior Lecturer in Ethics and Public Policy – Ph.D., Duquesne University; Carnegie Mellon, 1988–.

DONALD MARINELLI, (Affiliated) Professor of Drama and Arts Management (College of Fine Arts) – Ph.D., University of Pittsburgh; Carnegie Mellon, 1984–.

DAN MARTIN, Director, Master of Arts Management Program, and Associate Professor (College of Fine Arts) – M.F.A., Brooklyn College/City University of New York; Carnegie Mellon, 1993–.

MICHAEL MCCARTHY, Associate Teaching Professor of Information Systems Management – M.S., University of Pittsburgh; Carnegie Mellon, 1999–.

JOE MERTZ, Associate Teaching Professor – Ph.D., Carnegie Mellon; Carnegie Mellon, 1994–.

KARYN MOORE, Assistant Teaching Professor of Information Systems – M.S., Industrial Administration, Carnegie Mellon University; Carnegie Mellon, 2003–.

M. GRANGER MORGAN, Lord Chair Professor of Engineering and Public Policy, and Head, Department of Engineering and Public Policy – Ph.D., University of California at San Diego; Carnegie Mellon, 1974–.

DANIEL NAGIN, Theresa and H. John Heinz III Professor of Public Policy, and Research Director, National Consortium on Violence Research – Ph.D., University of Pittsburgh; Carnegie Mellon, 1979–.

DANIEL NEILL, Assistant Professor of Information Systems – M.S., University of Pittsburgh; Carnegie Mellon, 2007–.

ERIC WIBERG, Assistant Professor of Computer Science and Public Policy (joint with School of Computer Science) – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986–.

REMA PADMAN, Professor of Operations Research and Information Management; Faculty Chair, Master of Science in Health Care Policy and Management Program – Ph.D., University of Texas at Austin; Carnegie Mellon, 1989–.

LYNNE PASTOR, Visiting Associate Teaching Professor – M.S., Industrial Administration, Carnegie Mellon University; Carnegie Mellon, 2007–.

SETH RICHARDS-SHUBIK, Assistant Professor of Economics and Public Policy – Ph.D., University of Pennsylvania; Carnegie Mellon, 2011–.

STEPHEN ROEHRIG, Associate Professor of Information Systems and Public Policy – Ph.D., University of Pennsylvania; Carnegie Mellon, 1991–.

DENISE ROUSSEAU, H. J. Heinz II Professor of Organizational Behavior (joint with Graduate School of Industrial Administration) – Ph.D., University of California at Berkeley; Carnegie Mellon, 1994–.

KIRON SKINNER, (Courtesy) Assistant Professor of History and Political Science – Ph.D., Harvard University; Carnegie Mellon, 1999–.

DONALD SMITH, Professor of Practice; University Director for Economic Development – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995–.

KATHLEEN SMITH, Associate Teaching Professor – Ph.D., candidate, University of Pittsburgh; Carnegie Mellon, 1991–.

MICHAEL SMITH, Assistant Professor of Information Technology – Ph.D., Alfred P. Sloan School of the Massachusetts Institute of Technology; Carnegie Mellon, 2000–.

RICHARD STAFFORD, Distinguished Service Professor – M.S., Public Policy and Management, Carnegie Mellon University; Carnegie Mellon, 2005–.

SHELBY STEWMAN, Professor of Sociology and Demography – Ph.D., Michigan State University; Carnegie Mellon, 1973–.

ROBERT STRAUSS, Professor of Economics and Public Policy; Faculty Chair, Master of Science in Educational Technology Management Program – Ph.D., University of Wisconsin; Carnegie Mellon, 1979–.

LAURA SYNNOTT, Associate Teaching Professor, Healthcare Policy and Management – M.S., Health Services Administration, University of Michigan; Carnegie Mellon, 2004–.

JANUSZ SZCZYPULA, Associate Teaching Professor in Information Systems – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000–.

JOEL TARR, Richard S. Caliguiri Professor of Urban and Environmental History and Policy – Ph.D., Northwestern University; Carnegie Mellon, 1967–.

LOWELL TAYLOR, Professor of Economics and Public Policy; Associate Dean of Faculty – Ph.D., University of Michigan; Carnegie Mellon, 1990–.

RAHUL TELANG, Assistant Professor of Information Systems – Ph.D., Carnegie Mellon; Carnegie Mellon, 2001–.

MARK WESSEL, Dean University of Wisconsin; Carnegie Mellon, 1992–.

ROBERT C. WILBURN, Distinguished Service Professor – Ph.D., Princeton University; Carnegie Mellon, 2011–.

TIM ZAK, Associate Teaching Professor – M.B.A., New York University; Carnegie Mellon, 2011–.
Mellon College of Science

Frederick J. Gilman, Dean
Eric W. Grotzinger, Associate Dean for Undergraduate Affairs
Undergraduate Office: Doherty Hall 1324
http://www.cmu.edu/mcs/

The Mellon College of Science (MCS) has provided the undergraduate training for many of today’s leading scientists. We have earned national recognition for our integration of undergraduate education and research from such organizations as the National Science Foundation, the Howard Hughes Medical Institute, and the Beckman Foundation. MCS students gain a broad education in science, mathematics, and the liberal arts while using state-of-the-art computational approaches in their courses, laboratories, and research activities. Our faculty members are committed to teaching as well as to a wide range of scientific research. This combined emphasis on education and research brings special benefits to students, including increased awareness of current scientific developments that are incorporated in classroom instruction, and, most importantly, opportunities to participate with faculty, graduate students, and other research scientists in a variety of research projects.

In the context of rigorous training in each field, the MCS curriculum emphasizes problem-solving, communication, and analytical skills, and it teaches our students the value of hard work and discipline. Our students go on to highly successful careers in a broad range of fields like astrophysics, biotechnology, computer science, business management, environmental science, health care policy, investment banking, marketing analysis, medicine, patent law, and pharmaceuticals. Our alumni credit their education in science for preparing them for a lifetime of learning and achievement; their employers attest to their ability to succeed and to continue learning in an ever-changing world.

The MCS Departments of Biological Sciences, Chemistry, Mathematical Sciences, and Physics each outline their degree programs and courses in the departmental sections. Each program is based on a core of courses required by the college — two semesters each of calculus and physics and one semester each of chemistry, biology, and computer science. These courses lay a broad foundation in the sciences and not only enable our students to choose a major from any of the programs offered in MCS, but also prepare them for exploration of interdisciplinary aspects of science.

Students select their major in the spring of the first year so that the sophomore year begins with a focus within a department. Most of the courses required within a major are scheduled in the sophomore and junior years, leaving much of the senior year and part of the junior year open for electives. This provides the opportunity to participate in undergraduate research, explore interdisciplinary studies, study abroad, pursue additional majors or minors in other fields, or take other specialty courses oriented toward immediate job placement upon graduation or entry into graduate studies.

Tailoring Your Education

The Mellon College of Science offers students tremendous opportunity for tailoring their education to meet individual professional objectives. Whether you target your degree to a particular field in your discipline via departmental options and concentrations, add a secondary major, minor, or degree to your primary degree program, participate in honors programs, or pursue a master’s degree along with your bachelor’s degree, MCS has much to offer you. Many of these opportunities are outlined below.

Departmental Concentrations

Each department in MCS offers degrees and programs that allow students to explore particular fields within a science discipline. These are outlined below — see the departmental sections for further details.

Biological Sciences

• Biochemistry
• Biophysics
• Cell Biology
• Computational Biology
• Developmental Biology
• Genetics
• Molecular Biology
• Neuroscience

Chemistry

• Biochemistry

• Colloids, Polymers, and Surfaces
• Computational Chemistry
• Environmental Chemistry
• Management
• Material Chemistry
• Polymer Science

Mathematical Sciences

• Computational and Applied Mathematics
• Computational Finance
• Discrete Mathematics and Logic
• Mathematics
• Operations Research
• Statistics

Physics

• Applied Physics
• Astrophysics
• Biological Physics
• Chemical Physics
• Computational Physics

Minors, Double Majors, and Double Degrees

As an MCS student, you can pursue additional majors and minors to complement your primary degree, not only within the science college, but also through the other colleges at Carnegie Mellon. Carnegie Mellon offers many exciting interdisciplinary majors and minors, some of which are listed below. In addition, every college and most departments have designed minors or second majors in their discipline so that you can gain expertise in their fields as well.

Some students choose to gain this expertise by following a double degree program. This results in two distinct bachelor’s degrees. Please see the section on Undergraduate Academic Regulations for a more formal definition of these “Multiple Degree” programs.

Interdisciplinary Majors and Minors

Here is a sampling of just a few of the interdisciplinary minors and majors offered at Carnegie Mellon. Please see the appropriate sections elsewhere in this catalog for specific descriptions and course requirements.

• Biological Sciences and Psychology Major
• Computational Biology Major
• Engineering Studies Minor
• Environmental Policy Major
• Health Care Policy and Management Minor
• International Affairs Minor
• Mathematics and Economics Major
• Robotics Minor
• Scientific Computing Minor
• Technology and Policy Minor

For a complete list of the minors offered at Carnegie Mellon, please go to http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateoptions/

Intercollege Programs

MCS participates in two intercollege programs, the Bachelor of Science and Arts Degree program and the Science and Humanities Scholars program.

Enrollment for the Science and Humanities program is by invitation only for incoming first-year students, and by application for current students.

Bachelor of Science and Arts Degree Program (BSA)

Students in the Bachelor of Science and Arts Degree program are jointly admitted to MCS and the College of Fine Arts (CFA). This is a degree program for students who are naturally gifted in both the arts and the sciences, and allows for the combining of talents in these areas. More details can be found at http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/bxaintercollege/
Science and Humanities Scholars Program (SHS)

Students in the Science and Humanities Scholars Program (SHS) are jointly admitted to MCS and the Dietrich College of Humanities and Social Sciences (DC). Participants in this program follow a special general education core, but have the flexibility to choose a primary major in either of the two colleges. More detail can be found at http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/

Honors Degree Programs in MCS

Several of the departments in MCS offer students an opportunity to participate in a departmental honors degree program. Some of these programs result in a master’s degree along with the bachelor’s degree (see next section on accelerated master’s programs). These programs are listed below; see the department’s section of the catalog for more details.

- Honors Program in Research Biology
- Departmental Honors in Chemistry
- Honors B.S./M.S. Program in Chemistry
- Honors B.S./M.S. Program in Mathematical Sciences

Accelerated Master’s Programs

Carnegie Mellon offers some accelerated master’s programs for motivated students, whereby students complete both the bachelor’s and the master’s degree in four or five years. Some programs are in the student’s home department in MCS as part of an honors program, while others are offered through one of our graduate schools at Carnegie Mellon. Below is a listing of the programs currently available to MCS students; please see the appropriate section of the catalog for more details.

- Honors B.S./M.S. Program in Chemistry
- Honors B.S./M.S. Program in Mathematical Sciences
- Accelerated Master’s Program in the Heinz College
- Accelerated Master’s Program in Biotechnology Management (joint program between the Heinz College, Mellon College of Science, and the Tepper School of Business)

Pre-Professional Programs

Many students in the Mellon College of Science decide to pursue professional training such as medical school or law school after completing their undergraduate work. Carnegie Mellon offers strong advising services to support these students. Through these programs, students get help with everything from course selection to identification of important experiential opportunities to the application process itself.

Health Professions Program

Faculty Contact: Justin Crowley

Please see the Undergraduate Options section for details on the Health Professions Program.

Pre-Law Advising Program

Faculty Contact: Joseph Devine

Please see the Undergraduate Options section for details on the Pre-Law Advising Program.

University Self-Defined Majors

With a well-thought proposal, you may be able to pursue a major you have designed to meet your particular interests and goals. Please see the catalog section on Undergraduate Options at http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateoptions/

Study Abroad

There are many programs for studying abroad, usually during your junior year. Please see the catalog section on Undergraduate Options for more details, and talk with the Office of International Education to get information and advice specifically for you.

Applying Your Education Through Research

An important feature of education in MCS is the opportunity for undergraduate research experience. This experience may be arranged as a course taken for credit or occasionally as a part-time job. Our web site (www.cmu.edu/mcs/) offers a range of useful information including links to faculty research areas, links to undergraduate research programs at other institutions, and ideas on how to get involved. Because of the strong research base of MCS, undergraduate research positions offer an exciting opportunity to apply your theoretical training to participate in the discovery of new knowledge.

Students can earn MCS Research Honors for significant research accomplishments; see the policy outlined below for the requirements.

Mellon College of Science Research

Undergraduates in the Mellon College of Science will be awarded MCS College Honors at the completion of their degree if they have met one of these requirements:

1. Successfully completed the Honors B.S./M.S. program in the Department of Chemistry or Department of Mathematical Sciences.
2. Successfully completed the departmental honors program in the Department of Biological Sciences or the Department of Chemistry.
3. Earned a cumulative grade point average of 3.20 or higher and carried out significant research. Typically, this would consist of an academic project carried out for at least two semesters. However, a single project that spans a summer and a semester or that the research mentor deems to be significant and sustained, even if the student worked for pay rather than credit, will be allowed. In addition, some form of public dissemination of this research, which has been approved by the Associate Dean of MCS, such as a peer reviewed publication, research thesis, or presentation at an external scientific meeting is required. The Meeting of the Minds by itself is not sufficient and participation in a preapproved judged competition, such as Sigma Xi, is necessary.

Final approval of nominations for MCS Honors will come from the Dean of MCS and the Associate Dean for Undergraduate Affairs.

Research Centers

The Mellon College of Science is home to a number of innovative research centers. These centers are particularly strong because of the interdisciplinary collaboration of their scientists. This interdisciplinary research brings international prestige to the college. Many students conduct undergraduate research with one of these centers.

The Art Conservation Research Center is dedicated to helping museums, libraries and archives improve the ways of caring for their collections. For over 50 years, the Center has been a world leader in discovering the origins of aging problems that threaten cultural property and in developing practical and effective strategies to inhibit or avoid deterioration.

The Bruce and Astrid McWilliams Center for Cosmology joins research efforts in astrophysics and particle physics and partners with computer science, statistics, and other disciplines to unravel the mysteries of the universe.

The Center for Macromolecular Engineering’s goals are to enhance the polymer science community by developing new methods to prepare advanced polymer materials, train and develop tomorrow’s scientists, and transfer technology to industry.

The Institute for Green Science has been established as a research, education, and participation center in which a holistic approach to sustainability science is being developed. The focus of the institute is in three areas: renewable energy technologies, chemical feedstocks, and benign alternatives to polluting technologies.

The Molecular Biosensor and Imaging Center uses an interdisciplinary approach to develop reagents, microscopes, and imaging tools and applies them to the investigation of fundamental problems in biology and biotechnology.
The Pittsburgh NMR Center for Biomedical Research is a joint program between Carnegie Mellon University and the University of Pittsburgh. It is supported as a Biotechnology Resource Center by the National Institutes of Health.

The Pittsburgh Supercomputing Center provides information on advanced scientific computing for engineering and research.

The Lane Center for Computational Biology seeks to realize the potential of machine learning for expanding our understanding of complex biological systems. A primary goal of the Center is to develop computational tools that will enable automated creation of detailed, predictive models of biological processes, including automated experiment design and data acquisition.

First Year for Science Students

An MCS education is based on a broad foundation in the sciences: two semesters each of calculus and physics and one semester each of biology, chemistry and computer science. This foundation corresponds to the following courses required for all MCS students.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
</tr>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
</tr>
<tr>
<td>or 15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>or 21-124</td>
<td>Calculus II for Biologists and Chemists</td>
</tr>
<tr>
<td>33-111</td>
<td>Physics I for Science Students</td>
</tr>
<tr>
<td>33-112</td>
<td>Physics II for Science Students</td>
</tr>
</tbody>
</table>

In the first year, students take two semesters of calculus, 21-120 Differential and Integral Calculus and 21-122 Integration, Differential Equations and Approximation or 21-124 Calculus II for Biologists and Chemists. They also take three of the remaining five science core courses. The other two science core courses are completed by the end of the junior year. Additional courses in the first year include one course from the intended major, humanities, social sciences or fine arts courses; and Computing @ Carnegie Mellon, a course that introduces students to the computing environment and ethics of computing at Carnegie Mellon.

With this broad science background, a student is prepared to undertake any of the degree programs offered by the college when selecting a major at the end of the first year.

Fall Semester 41-50 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Science Core Course</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Science Core Course</td>
</tr>
<tr>
<td>76-102</td>
<td>Interpretation and Argument</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Optional First-Year Seminar or Discovery-Based Lab</td>
</tr>
</tbody>
</table>

Spring Semester 43-53 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>or 21-124</td>
<td>Calculus II for Biologists and Chemists</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Science Core Course</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Departmental Elective from Intended Major</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities, Social Sciences, or Fine Arts Course</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Optional Free Elective Course or Discovery-Based Lab</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Optional First-Year Seminar</td>
</tr>
</tbody>
</table>

Notes:

1. Departmental electives from the intended major are as follows:
   - Biological Sciences or Chemistry: 09-106 Modern Chemistry II (1 units)
   - Mathematical Sciences: 21-127 Concepts of Mathematics (1 units)
   - Physics: 33-104 Experimental Physics (1 units)

2. A free elective is any Carnegie Mellon course. However, a maximum of nine units of physical education, military science and/or STUCO courses may be taken as free electives in any MCS degree program. Credit earned for physical education, military science and STUCO courses will not be calculated in a student’s QPA.

3. Students who enter with advanced placement credits will follow a similar schedule with modifications for their AP work.

MCS First-Year Laboratory Courses

In addition to the basic schedule that was outlined above, students have the option to take one of the following 4 or 6 unit elective inquiry-based laboratory courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>03-115</td>
<td>Plague Genomics Research</td>
</tr>
</tbody>
</table>

The Department of Biological Sciences offers a two-semester research course in bacteriophage genomics. If you are interested in biological research, this course may be ideal for you. Genomics research combines experimental and computational approaches for large-scale analysis of the biological information contained in DNA sequences. The most abundant biological entities are bacteriophages. Their enormous diversity and number make bacteriophages important models for the study of gene structure, function and regulation, population genetics and evolution. This program is part of a national project sponsored by the Howard Hughes Medical Institute at selected institutions.

03-126 Cellular Response to the Environment

This laboratory course provides a multifaceted view of the cell, with the opportunity for new discovery, through microscopic imaging of a cell’s response to environmental changes. We will identify yeast gene products that undergo changes in expression or subcellular localization after simple environmental perturbations or drug treatments. Students will be trained in basic molecular biological methods, including recombinant DNA manipulation, and basics of functional genomic resources.

Humanities, Social Sciences, and Fine Arts Requirements

All candidates for the bachelor’s degree must complete a minimum of 72 units offered by the Dietrich College of Humanities and Social Science and/or the College of Fine Arts. These courses for MCS students are to meet the following distribution requirements:

**A. Designated Writing Course (9 units)**

76-101 Interpretation and Argument | 9 |

**B. Distributional Course Requirements (27 units)**

Complete three courses, one each from Category 1, Category 2, and Category 3. Listed below are examples of courses that meet the requirement for each category. Students wishing to substitute a course that is not listed should meet with their advisor.

**Category 1: Cognition, Choice and Behavior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-130</td>
<td>Introduction to Ethics</td>
</tr>
<tr>
<td>80-150</td>
<td>Nature of Reason</td>
</tr>
<tr>
<td>80-180</td>
<td>Nature of Language</td>
</tr>
<tr>
<td>80-208</td>
<td>Critical Thinking</td>
</tr>
<tr>
<td>80-220</td>
<td>Philosophy of Science</td>
</tr>
<tr>
<td>80-221</td>
<td>Philosophy of Social Science</td>
</tr>
<tr>
<td>80-230</td>
<td>Ethical Theory</td>
</tr>
<tr>
<td>80-241</td>
<td>Ethical Judgments in Professional Life</td>
</tr>
<tr>
<td>80-270</td>
<td>Philosophy of Mind</td>
</tr>
<tr>
<td>80-271</td>
<td>Philosophy and Psychology</td>
</tr>
<tr>
<td>80-312</td>
<td>Philosophy of Mathematics</td>
</tr>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>85-221</td>
<td>Principles of Child Development</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
</tr>
<tr>
<td>85-251</td>
<td>Personality</td>
</tr>
<tr>
<td>85-261</td>
<td>Abnormal Psychology</td>
</tr>
<tr>
<td>85-390</td>
<td>Human Memory</td>
</tr>
<tr>
<td>88-120</td>
<td>Reason, Passion and Cognition</td>
</tr>
</tbody>
</table>

**Category 2: Economic, Political and Social Institutions**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-101</td>
<td>Introduction to Engineering and Public Policy</td>
</tr>
<tr>
<td>36-303</td>
<td>Sampling, Survey and Society</td>
</tr>
<tr>
<td>70-332</td>
<td>Business, Society and Ethics</td>
</tr>
<tr>
<td>70-420</td>
<td>Entrepreneurship for Scientists</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>79-205</td>
<td>20th Century Europe</td>
</tr>
<tr>
<td>79-306</td>
<td>Delinquency, Crime, and Juvenile Justice: 1970s to the Present</td>
</tr>
<tr>
<td>79-316</td>
<td>Photography the First 100 Years, 1839-1939</td>
</tr>
<tr>
<td>79-330</td>
<td>Medicine and Society</td>
</tr>
<tr>
<td>79-331</td>
<td>Body Politics: Women and Health in America</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
</tr>
<tr>
<td>79-340</td>
<td>Gender, Race, and American Sport: Historical and Contemporary Perspectives</td>
</tr>
<tr>
<td>79-341</td>
<td>The Cold War in Documents and Film</td>
</tr>
<tr>
<td>79-374</td>
<td>American Environmental History: Critical Issues</td>
</tr>
<tr>
<td>79-377</td>
<td>Food, Culture, and Power: A History of Eating</td>
</tr>
<tr>
<td>79-392</td>
<td>History of Modern Warfare</td>
</tr>
<tr>
<td>80-135</td>
<td>Introduction to Political Philosophy</td>
</tr>
<tr>
<td>80-136</td>
<td>Social Structure, Public Policy &amp; Ethics</td>
</tr>
<tr>
<td>80-226</td>
<td>Revolutions in Science</td>
</tr>
<tr>
<td>80-235</td>
<td>Political Philosophy</td>
</tr>
<tr>
<td>80-243</td>
<td>Business Ethics</td>
</tr>
<tr>
<td>80-245</td>
<td>Medical Ethics</td>
</tr>
<tr>
<td>80-276</td>
<td>Philosophy of Religion</td>
</tr>
<tr>
<td>80-341</td>
<td>Computers, Society and Ethics</td>
</tr>
<tr>
<td>80-344</td>
<td>Management, Environment, and Ethics</td>
</tr>
</tbody>
</table>
Transfer into MCS Departments

Undergraduate students admitted to MCS can choose to pursue any major within MCS. This choice must be made prior to the first semester of the sophomore year (normally during the second semester of the first year) and does not require approval by any department.

Undergraduate students admitted to colleges other than MCS and wishing to transfer into an MCS department during their first year should consult with the MCS Associate Dean for Undergraduate Affairs. Students may submit an internal transfer request no earlier than mid-term of the spring semester of the first year. Potential transfer students must also have successfully taken 21-120 Differential and Integral Calculus and, depending on major choice, one of the following: 03-121 Modern Biology, 09-105 Introduction to Modern Chemistry I, or 33-111 Physics I for Science Students.

MCS undergraduate students beyond the first year wishing to transfer into another MCS department may do so if they are not on academic probation and if there is room in the department of their choice. If the demand for any department exceeds the space available, then the department will admit students based on a comparative evaluation of all applicants at the end of each semester, up to the limit of available space.

Undergraduate students not in MCS and wishing to transfer into a department in MCS beyond the first year will be considered for transfer on a space available/academic performance basis. An MCS department may refuse a transfer to a non-MCS student if there are space restrictions and/or if the student’s chance for success is determined to be questionable based on past academic performance.

Procedure for transfer of students from another university into an MCS department:

A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student’s record is sent to the appropriate department for evaluation and a decision on acceptance. The MCS department head has the right to refuse to accept the student if there are space restrictions and/or if the student’s chance for success in the MCS department is determined to be questionable based on past academic performance.

Academic Standards and Actions

MCS Dean’s List

Each semester MCS recognizes those students with outstanding academic records by naming them to the Dean’s List. The criteria for such recognition are as follows:

Dean’s List

The student must earn a quality point average of at least 3.5 while completing a minimum of 36 factorable units and earning no incomplete grades.

Dean’s List High Honors

The student must earn a quality point average of at least 3.75 while completing a minimum of 36 factorable units and earning no incomplete grades.

Probation, Suspension, and Drop

In the first year, quality point averages below 1.75 in either semester invoke an academic action. For all subsequent semesters an academic action will be taken if the semester QPA or the cumulative QPA (excluding the first year) is below 2.00.

The progression below between probation, suspension, and drop is typical. However, for example, in unusual circumstances, MCS College Council may choose to suspend or drop a student without prior probation.

Probation

The action of probation will be taken if:

- One semester of the first year is below 1.75 QPA.
- The semester QPA of a student in good standing beyond the first year falls below 2.00. The term of probation is one semester as a full-time student. First-year students are no longer on probation at the end of the second semester if their semester QPA is 1.75 or above.

A student is occasionally continued on probation who has had one semester on probation and is not yet meeting minimum requirements but whose record indicates that the standards are likely to be met at the end of the next semester of study.

Suspension

A student who does not meet minimum standards at the end of one semester of probation will be suspended.

A first-year student will be suspended if the QPA from each semester is below 1.75.

A student in the third or subsequent semester of study will be suspended if the semester factor or the cumulative factor (excluding the first year) is below 2.00 for two consecutive semesters.

The minimum period of suspension is one academic year (two semesters). At the end of that period a student may return to school on probation by:

- Receiving permission in writing from the Associate Dean of MCS.
- Completing a Return from Leave form from Enrollment Services.
- Providing transcripts and clearance forms if the student has been in a degree program at another college or university, even though academic credit earned will not transfer to Carnegie Mellon unless prior approval has been granted by the Associate Dean.

Employment within the university in non-student jobs is possible for students on academic suspension, subject to the hiring criteria of the hiring department. However, a student on academic suspension wishing to accept a job on campus must speak with the Associate Dean of the student’s college to ensure that the employment will not constitute a violation of the terms of suspension. The Associate Dean will generally allow such employment, in consultation with the Dean of Student Affairs. One employment benefit not available to students on academic suspension
who accept a full-time job with the University is the option to take courses through tuition remission. The option to take courses becomes available only after the academic suspension is over.

Drop
This is a permanent severance from the Mellon College of Science. Students are dropped when it seems clear that they will never be able to meet minimum standards. A student who has been suspended and who fails to meet minimum standards after returning to school is dropped.

A student who has been academically dropped or academically suspended and who is not employed by the University must absent themselves from campus and is, for the term of the suspension, barred from all activities and affiliations that stem from one’s status as an enrolled student. These include registering or enrolling for courses, sitting in on classes, living in residence halls or Greek houses, membership and participation in student activities, and employment in student jobs. (NOTE: Exceptions to the restriction from student jobs for students on academic suspension will in general be granted for summer employment if the position was accepted prior to the decision to suspend.)

Graduation Requirements
A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of at least 2.00 for all courses taken or, alternatively, for only those courses taken after the first year. A minimum of 360 units must be completed. This will include the MCS Science Core Courses, humanities or fine arts requirements and all departmental course requirements.

Students will be required to meet the residency requirement and to have met all financial obligations to the university before being awarded a degree. The residency requirement is detailed in the Academic Regulations section of the catalog.

A student may seek permission to modify graduation requirements by petition to the MCS College Council.

Graduation Honors
There are two types of honors awarded at graduation.

University Honors
University Honors are automatically awarded to students who have earned a cumulative Q.P.A. of 3.5 or better after seven semesters.

College Research Honors
Please see the section “Mellon College of Science Research Honors” for information on how to qualify for College Research Honors.
Minors Offered by the Mellon College of Science

The Mellon College of Science offers several minors to students interested in broadening their scientific training or acquiring a level of expertise in a particular scientific field. The intercollege minors described below are designed to supplement your degree in science; the departmental minors offer you a means of exploring another field and are open to students throughout the university.

Intercollege Minors
Please see the descriptions below.

• Environmental Science
• Health Care Policy and Management
• Scientific Computing

Departmental Minors in the Mellon College of Science

For descriptions, please see the departmental sections which follow.

• Biological Sciences
• Chemistry
• Computational Finance
• Discrete Mathematics and Logic
• Mathematical Sciences
• Physics

Minor in Environmental Science
Advisor: Eric Grotzinger

The primary mission of the environmental sciences minor is to prepare students in the Mellon College of Science for careers or graduate education in the diverse fields of environmental science. We feel strongly that these endeavors must be grounded in strong fundamental science; consequently, the program extends majors in the Mellon College of Science. We also award minors to students from other colleges, provided that they can build a course of study with sufficient scientific rigor to meet the standards of the program.

As a capstone program, the minor is built around advanced courses that extend as well as broaden the specialized education associated with the major programs. Environmental sciences are highly interdisciplinary in nature, and while it is necessary that students have an exposure to introductory courses in several of these disciplines, it is by no means sufficient; in-depth knowledge is required. We encourage all students to pursue generally broad studies, including subjects that encompass human interactions with the environment, and will provide guidance to all students interested in the area. We encourage those students who intend to devote focused attention to environmental sciences to pursue this minor.

Environmental Sciences are broadly defined as pursuits designed to develop fundamental understanding of the natural environment and human interactions with the environment. Research problems are frequently motivated by perceived problems (air, water and soil pollution, reduction in biodiversity, global climate change, etc...), but inevitably extend to the fundamental mechanisms underlying these phenomena. Research can be highly specialized (focusing for example on the biochemistry of a particular enzyme or the synthesis of a particular catalyst) or highly general (focused for example on the complex, nonlinear interactions of populations on complex ecosystems). Our program is designed to ensure that students of the field are conversant with questions on all of these scales, from the microscopic to the global.

Required Courses:
Science Requirements (27 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-219</td>
<td>Modern Organic Chemistry</td>
<td></td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-220</td>
<td>Modern Organic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>03-231/232</td>
<td>Biochemistry I</td>
<td>9</td>
</tr>
</tbody>
</table>

Laboratory Requirement (12 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
</tbody>
</table>

Statistics Requirement (9 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-217</td>
<td>Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional Course Requirements:

Complete one course from each of the following groups (substitutions can be made with the approval of the Environmental Science Advisor).

Science (Mechanics)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-510</td>
<td>Introduction to Green Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>06-510</td>
<td>Global Atmospheric Chemistry, Fundamentals, and Data Analysis Methods</td>
<td>9</td>
</tr>
<tr>
<td>06-630</td>
<td>Atmospheric Chemistry, Air Pollution and Global Change</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Course credit may be assigned for research, fieldwork, or coursework performed outside of CMU at the discretion of the minor advisor.</td>
<td></td>
</tr>
</tbody>
</table>

Engineering (Process)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-100</td>
<td>Introduction to Civil and Environmental Engineering</td>
<td>12</td>
</tr>
<tr>
<td>12-201</td>
<td>Geology</td>
<td>9</td>
</tr>
<tr>
<td>12-251</td>
<td>Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-651</td>
<td>Air Quality Engineering</td>
<td>9</td>
</tr>
<tr>
<td>19-440</td>
<td>Combustion and Air Pollution Control</td>
<td>9</td>
</tr>
</tbody>
</table>

Policy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-424</td>
<td>Energy and the Environment</td>
<td>9</td>
</tr>
<tr>
<td>19-448</td>
<td>Science, Technology &amp; Ethics</td>
<td>9</td>
</tr>
<tr>
<td>73-148</td>
<td>Environmental Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-358</td>
<td>Economics of the Environment and Natural Resources</td>
<td>9</td>
</tr>
<tr>
<td>79-372</td>
<td>Perspectives on the Urban Environment</td>
<td>9</td>
</tr>
<tr>
<td>79-381</td>
<td>Energy, Environment, Globalization in the Americas</td>
<td>9</td>
</tr>
<tr>
<td>79-375</td>
<td>China’s Environmental Crisis</td>
<td>9</td>
</tr>
<tr>
<td>80-344</td>
<td>Management, Environment, and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>89-238</td>
<td>Materials, Energy and Environment</td>
<td>9</td>
</tr>
</tbody>
</table>

Minor in Health Care Policy and Management

Sponsored by: H. John Heinz III College, Dietrich College of Humanities and Social Sciences
Mellan College of Science

Faculty Advisors:
Caroline Acker, Dietrich College of Humanities and Social Sciences
Patti Lee, H. John Heinz III College
Justin Crowley, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum 60 units minimum

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100 Principles of Economics or 08-220 Policy Analysis I or the equivalent by approval.

Required Courses 39 units

Students are required to take the following courses.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-330</td>
<td>Medicine and Society</td>
<td>9</td>
</tr>
<tr>
<td>90-836</td>
<td>Health Systems</td>
<td>6</td>
</tr>
<tr>
<td>90-861</td>
<td>Health Policy</td>
<td>6</td>
</tr>
<tr>
<td>94-705</td>
<td>Health Economics</td>
<td>12</td>
</tr>
</tbody>
</table>

27 units

Elective Courses
Complete a minimum of 27 units.
### Heinz College Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-708</td>
<td>Healthcare Ethics</td>
<td>6</td>
</tr>
<tr>
<td>90-721</td>
<td>Healthcare Management</td>
<td>6</td>
</tr>
<tr>
<td>90-818</td>
<td>Health Care Quality &amp; Performance Improvement</td>
<td>6</td>
</tr>
<tr>
<td>90-830</td>
<td>Introduction to Financial Management of Health Care</td>
<td>6</td>
</tr>
<tr>
<td>90-831</td>
<td>Advanced Financial Management of Health Care</td>
<td>6</td>
</tr>
<tr>
<td>90-832</td>
<td>Health Law</td>
<td>12</td>
</tr>
<tr>
<td>90-863</td>
<td>Health Policy II</td>
<td>6</td>
</tr>
<tr>
<td>94-706</td>
<td>Healthcare Information Systems</td>
<td>12</td>
</tr>
</tbody>
</table>

### Humanities and Social Sciences Courses (9 units each)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-494</td>
<td>Healthcare Communications</td>
<td>9</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
<td>9</td>
</tr>
<tr>
<td>79-383</td>
<td>Epidemic Disease and Public Health</td>
<td>9</td>
</tr>
<tr>
<td>80-245</td>
<td>Medical Ethics</td>
<td>9</td>
</tr>
<tr>
<td>80-247</td>
<td>Ethics and Global Economics</td>
<td>9</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-442</td>
<td>Health Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-446</td>
<td>Psychology of Gender</td>
<td>9</td>
</tr>
</tbody>
</table>

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

### Minor in Scientific Computing

**Advisor:** Eric Grotzinger

Sometimes called "computational science," scientific computing is the application of high-performance computers and modern computational technologies to problems in the sciences and engineering. Research in this area is inherently multidisciplinary, requiring strong ties with a scientific discipline.

MCS students can easily build on their scientific training with this applied computational program. The curriculum consists of five areas of concentration, which span the natural sciences, mathematics, programming and research. The curriculum is structured to allow flexibility in choosing courses that meet students’ particular interests or best compliment their major. The minor is also a natural choice for students majoring in any technical area.

#### Required Courses

Students must meet the requirements of the following categories:

A. **Non-Introductory Science Requirement (9-12 units)**

Complete 1 course from Biological Sciences, Chemistry, or Physics at the 200 level or higher, excluding those courses listed below as part of the requirements of the minor. Courses with a significant science component from other colleges may be substituted with approval from the program administrator.

B. **Computational Science Requirement (18-24 units)**

Complete 2 of the following courses:

- **03-250** Introduction Computational Biology 12
- **03-511** Computational Molecular Biology and Genomics 9
- **09-560** Computational Chemistry 12
- **15-386** Neural Computation 9
- **33-241** Introduction to Computational Physics 9

C. **Computational Methods Requirement (9 units)**

Complete one of the following courses from outside of your home department.

- **21-320** Symbolic Programming Methods 9
- **21-369** Numerical Methods 9
- **32-232** Mathematical Methods of Physics 10
- **33-506** Advanced Computational Physics 9
- **36-410** Introduction to Probability Modeling 9

D. **Applied Scientific Computing Research Project(s) (9 units)**

Complete one approved research project in an area of applied scientific computing. In some cases, this research could be replaced with 9 units of an approved project-based course in advanced scientific computing. The administrator of the minor will maintain a list of appropriate courses. Under special circumstances summer research may count toward this requirement, although it cannot be counted toward the units required for graduation.

E. Complete any additional course from category C or D (9 units)
A major revolution is occurring in the field of biological sciences. Biology is undergoing unprecedented technological advances in biochemistry, biophysics, cell biology, genetics, molecular biology, developmental biology, neuroscience and computational biology. Carnegie Mellon’s Department of Biological Sciences is nationally recognized as one of the outstanding departments in these areas. Advances in basic research are already being used to solve problems, not only in medicine and public health, but also in areas such as agriculture, forestry, mining, energy, and in industrial and pharmaceutical manufacturing processes. The department provides its students with an education that has both intellectual breadth and depth of exposure to modern research biology. This education can be used to gain employment immediately after graduation in government, industry or academic research laboratories, or to pursue graduate studies in a variety of areas such as science, medicine, public health, law, or business. A degree in biological sciences provides excellent preparation for medical school or other graduate programs in the health professions. These students are aided by the Carnegie Mellon Health Professions Program (HPP), an advisory and resource service for all Carnegie Mellon students who are considering careers in the health care field. (See the HPP section in this catalog or www.cmu.edu/hpp for more information.)

The department offers a Bachelor of Science (B.S.) degree in Biological Sciences. This program has a distinctive core curriculum that provides a foundation in biology, chemistry, computer science, mathematics, and physics. In addition to the core courses, the program includes six biology electives, five free electives as well as eight humanities, social science and fine arts electives. With these electives, students can shape a degree program according to their own interests and career goals. For students who have an interest in a particular field of biology and wish to have a specialized focus, the department offers options in biochemistry, biophysics, cell biology, computational biology, developmental biology, genetics, molecular biology and neuroscience that provide the relevant training in each area. The options are especially recommended for students who are considering graduate school in one of these areas. The B.S. in Biological Sciences/Neuroscience Track is available to those students who wish to pursue an in-depth study of neuroscience.

In this exciting era that includes the influence of biology and the life sciences on many fields from medicine to law, the in-depth exposure to multiple disciplines provides opportunities for students to prepare for involvement at the forefront of emerging fields, markets, and policy changes. The Department of Biological Sciences at Carnegie Mellon is working at these new interfaces through interdisciplinary research and educational programs. Innovative interdisciplinary degrees which are offered by the department include the inter-college B.S. degree in Computational Biology as well as an unified B.S. degree in Biological Sciences and Psychology. Students also explore interdisciplinary studies through the Science and Humanities Scholars program, or pursue interests at the interface between the arts and sciences through the Bachelor of Science and Arts (B.S.A.) degree program combining biological sciences with a discipline in the College of Fine Arts. A stand-alone Bachelor of Arts (B.A.) degree is available for students who wish to expand their educational training into other fields. Many students choose to broaden their education by pursuing minors and additional majors in disciplines throughout the university, not just within the Mellon College of Science.

One of the most important features of the Department of Biological Sciences is the opportunity for undergraduate students to interact with faculty. Providing a solid foundation to scientific practice is critical; therefore, the department offers first-year students a variety of inquiry-based, hands-on courses that incorporate a wide range of topics and interests within Biological Sciences. These courses kick-start the transformation of science students to scientists. We encourage our students to get to know their faculty through one of these courses, or through mentored, independent research projects in the faculty laboratories. Our faculty members are prominent research scientists who also teach beginning and advanced courses. The upper level teaching laboratories are located in the same building as the faculty research laboratories and share scientific equipment. We encourage students to be aware of the faculty research work and to develop research projects with faculty. While such research is usually most important in the senior year, it may begin earlier in a student’s undergraduate training. The department has an Honors Program in Research Biology to facilitate a more intensive involvement in research for eligible students. During the past four years, more than 80 percent of the undergraduate biology majors have worked with faculty on their research and, in some cases, have been co-authors of research papers and have given presentations at national meetings.

### B.S. Biological Sciences

The Bachelor of Science (B.S.) in Biological Sciences is built around a core program and elective units as detailed in the following section.

#### Degree Requirements:

<table>
<thead>
<tr>
<th>Biological Sciences</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231 Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-201/202 Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-250 Introduction to Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>or 03-251 AND 03-252</td>
<td></td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-344 Experimental Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 03-345 Experimental Cell and Developmental Biology</td>
<td></td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxxx Biological Sciences Electives</td>
<td>54</td>
</tr>
</tbody>
</table>

Total Biology units: 130

Details on electives can be found in the "Biological Sciences Electives" section (see below).

#### Mathematics, Physics and Computer Science

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>or 21-124 Calculus II for Scientists</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
</tr>
<tr>
<td>33-112 Physics II for Science Students</td>
</tr>
<tr>
<td>15-110 Principles of Computing</td>
</tr>
<tr>
<td>or 09-10x Computing at Carnegie Mellon</td>
</tr>
</tbody>
</table>

Total Science units: 57

#### Chemistry

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
</tr>
<tr>
<td>or 09-217 Organic Chemistry I</td>
</tr>
<tr>
<td>or 09-219 Modern Organic Chemistry</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II</td>
</tr>
<tr>
<td>or 09-220 Modern Organic Chemistry II</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
</tr>
<tr>
<td>09-222 Laboratory II: Organic Synthesis and Analysis</td>
</tr>
</tbody>
</table>

Total Chemistry units: 62

#### Elective Units

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Electives</td>
</tr>
<tr>
<td>Dietrich College/CAR Electives</td>
</tr>
<tr>
<td>Total Elective units</td>
</tr>
</tbody>
</table>

#### Minimum number of units required for degree:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
</tr>
</tbody>
</table>

### Biological Sciences Electives

The following specifications apply to Biological Sciences electives:

- At least 18 units must be at the 03-xxx level or above, exclusive of 03-445 Undergraduate Research.
- Up to three interdisciplinary electives may count as biology electives.
- Up to 18 units of 03-445 Undergraduate Research may count as general biology electives; a maximum of 36 units can count for the minimum units required for graduation.
Departmental Electives Group

- Courses in biology taken through cross-registration or study abroad at another university may count as electives if prior permission is obtained from the Carnegie Mellon Department of Biological Sciences advisor.

**Required Biology Electives:**

03-115/116 Phage Genomics Research 6
03-122 Organismic Botany 9
03-124 Modern Biology Laboratory 9
03-125 Evolution and History of Life 9
03-126 Cellular Response to the Environment 4
03-127 How Biological Experiments Work: A Project Course 6
03-203 Bench to Bedside: Process of Regenerative Therapeutics 6
03-230 Intro to Mammalian Physiology 9
03-315 Magnetic Resonance Imaging in Neuroscience 9
03-326 Evolution of Regulatory Genomics 4.5
03-327 Phylogenetics 4.5
03-350 Developmental Biology 9
03-362 Cellular Neuroscience 9
03-363 Systems Neuroscience 9
03-364 Developmental Neuroscience 9
03-380 Virology 9
03-390 Molecular and Cellular Immunology 9
03-391 Microbiology: Biophysical and Molecular Biology 9
03-392 Microbiology Laboratory 6
03-439 Introduction to Biophysics 9
03-442 Molecular Biology 9
03-445 Undergraduate Research 9
03-511 Computational Molecular Biology and Genomics 9
03-512 Computational Methods for Biological Modeling and Simulation 9
03-534 Biological Imaging and Fluorescence Spectroscopy 9
03-545 Honors Research 9
03-620 Techniques in Electron Microscopy 9
03-711 Computational Molecular Biology and Genomics 12
03-712 Computational Methods for Biological Modeling and Simulation 12
03-713 Bioinformatics Data Integration Practicum 6
03-715 Computational Genomics 12
03-726 Evolution of Regulatory Genomics 6
03-727 Phylogenetics 6
03-730 Advanced Genetics 12
03-740 Advanced Biochemistry 12
03-741 Advanced Cell Biology 12
03-742 Molecular Biology 12
03-744 Membrane Trafficking 9
03-751 Advanced Developmental Biology 12
03-761 Neural Plasticity 9
03-762 Advanced Cellular Neuroscience 12
03-763 Advanced Systems Neuroscience 12
03-815 Magnetic Resonance Imaging in Neuroscience 12
03-871 Structural Biophysics 12

**Interdisciplinary Electives Group**

Up to three of the following courses may count as biology electives:

09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates 9
09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry 9
09-521 Bioinorganic Chemistry 9
09-535 Applied Topics in Macromolecular and Biophysical Techniques 9
15-211 Fundamental Data Structures and Algorithms 12
21-127 Concepts of Mathematics 10
21-259 Calculus in Three Dimensions 9
21-260 Differential Equations 9
36-201 Statistical Reasoning and Practice 9
36-247 Statistics for Lab Sciences 9
42-202 Physiology 9
85-219 Biological Foundations of Behavior 9

**Options for the B.S. in Biological Sciences**

Students who wish to specialize in a particular area of biology can do so through a set of departmentally defined options. A student who completes the required biology electives for any option can have up to two noted on his or her transcript. Options need not be declared. The elective courses required for each of the options are listed below.

**Biochemistry Option**

**Required Biology Electives:**

03-740 Advanced Biochemistry 12
21-259 Calculus in Three Dimensions 9
or 21-260 Differential Equations 9

Any ONE of the following courses:

09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates 9
09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry 9
09-521 Bioinorganic Chemistry 9

**Recommended Biology Electives:**

03-442 Molecular Biology 9
03-534 Biological Imaging and Fluorescence Spectroscopy 9
03-439 Introduction to Biophysics 9
03-871 Structural Biophysics 12

**Biophysics Option**

**Required Biology Electives:**

03-340 Advanced Biochemistry 12
03-439 Introduction to Biophysics 9
21-259 Calculus in Three Dimensions 9
or 21-260 Differential Equations 9

**Recommended Biology Electives:**

03-315 Magnetic Resonance Imaging in Neuroscience 9
03-534 Biological Imaging and Fluorescence Spectroscopy 9
03-871 Structural Biophysics 12

**Cell Biology Option**

**Required Biology Electives:**

03-350 Developmental Biology 9
03-741 Advanced Cell Biology 12

Any ONE of the following courses:

03-362 Cellular Neuroscience 9
03-390 Molecular and Cellular Immunology 9

**Computational Biology Option**

**Required Biology Electives:**

03-711 Computational Molecular Biology and Genomics 12
15-210 Parallel and Sequential Data Structures and Algorithms 12

Any ONE of the following courses:

36-247 Statistics for Lab Sciences 9
21-260 Differential Equations 9
21-241 Matrices and Linear Transformations 10

**Recommended Biology Electives:**

03-512 Computational Methods for Biological Modeling and Simulation 9
15-451 Algorithm Design and Analysis 12
09-560 Computational Chemistry 12

**Developmental Biology Option**

**Required Biology Electives:**

03-350 Developmental Biology 9
03-442 Molecular Biology 9
03-751 Advanced Developmental Biology 12

**Recommended Biology Electives:**

03-326 Evolution of Regulatory Genomics 4.5
03-741 Advanced Cell Biology 12

**Genetics Option**

**Required Biology Electives:**

03-326 Evolution of Regulatory Genomics 4.5
03-327 Phylogenetics 4.5
03-442 Molecular Biology 9
03-750 Advanced Genetics 3

3 Minimum grade of B in 03-330 required.

**Recommended Biology Electives:**

03-391 Microbiology: Biophysical and Molecular Biology 9

**Molecular Biology Option**

**Required Biology Electives:**

03-442 Molecular Biology 9
09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates 9
03-726 Evolution of Regulatory Genomics 6
03-727 Phylogenetics 6

**Recommended Biology Electives:**
B.S. Biological Sciences/Neuroscience Track

The Bachelor of Science in Biological Sciences/Neuroscience Track provides an option for those Biological Sciences majors who are interested in an intensive curricular focus in neuroscience. The requirements of the Track are the same as those listed for the B.S. in Biological Sciences with the following changes to the biological sciences elective requirements:

Degree Requirements:

- 03-362 Cellular Neuroscience 9
- 03-363 Systems Neuroscience 9
- 03-761 Neural Plasticity 9

Plus three of the following electives:

- 03-315 Magnetic Resonance Imaging in Neuroscience 9
- 03-350 Developmental Biology 9
- 03-364 Developmental Neuroscience 9
- 03-534 Biological Imaging and Fluorescence Spectroscopy 9
- 03-385 Computer Vision 9
- 03-386 Neural Computation 9
- 42-202 Physiology 9
- 85-211 Cognitive Psychology 9
- 85-213 Human Information Processing and Artificial Intelligence 9
- 85-219 Biological Foundations of Behavior 9

B.S. Biological Sciences and Psychology

This major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences.

Note: Students entering from the College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the Mellon College of Science will earn a Bachelor of Science in Biological Sciences and Psychology. Students in the Joint Science and Humanities Scholars (SHS) program can complete the SHS educational core in Biological Sciences and Psychology. Students in the Mellon College of Science will earn a Bachelor of Science in Psychology and Biological Sciences.

Depending on a student’s home college (H&SS or MCS), General Education (GenEd) requirements will be different. GenEd requirements for H&SS (p.168) and MCS (p. 253) are found on their respective Catalog pages.

Degree Requirements:

<table>
<thead>
<tr>
<th>Biological Sciences</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
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</tr>
<tr>
<td>03-231 Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-202/203 Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxx General Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xx Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-xx Advanced Biology Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

| Total Biology units | 75 |

<table>
<thead>
<tr>
<th>Mathematics, Statistics, Physics and Computer Science</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
</tbody>
</table>

or 03-124 Calculus II for Biologists and Chemists

** Minimum number of units required for degree: 360 **
5.6 Please see description and requirements for electives under the B.S. in Biological Sciences section of this Catalog.

### Courses for the Minor in Biological Sciences

#### Prerequisites:
- 09-105 Introduction to Modern Chemistry
- 03-217 Organic Chemistry I

#### Required courses:
- 03-121 Modern Biology
- 03-230/232 Biochemistry I
- 03-240 Cell Biology

#### Minimum number of units required for the Minor in Biological Sciences:

360 units

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B.S. Computational Biology

The Bachelor of Science in Computational Biology is now listed in the Intercollege (p. 62) section of this catalog. It is a joint degree program offered between the Mellon College of Science and the School of Computer Science. Current MCS students interested in pursuing this degree should contact Dr. Maggie Braun (DH 1320).

Masters Degree in Computational Biology

Students who are interested in more advanced training in this emerging field may want to consider the Master of Science Program in Computational Biology. For more information about this program, contact the Biological Sciences Graduate Programs Office (bio-gradoffice@andrew.cmu.edu).

Honors Program in Research Biology

The departmental Honors Program offers an opportunity to become extensively involved in research. The program requires students to conduct an independent project and to prepare a formal thesis that is written and defended in the senior year. This program does not preclude a student from completing any of the options within the department nor is it the only way in which students can participate in undergraduate research although it is excellent preparation for graduate studies.

Minor in Biological Sciences

All university students are eligible to pursue a minor in biological sciences in conjunction with a major in any other department in the university. A minimum of six biological sciences courses and two chemistry prerequisites must be completed to fulfill the minor in biological sciences. The curriculum includes four required courses and two elective courses as specified below. Units awarded for undergraduate research are not applicable to elective courses. Courses taken in other departments or colleges will be considered on an individual basis.

#### Courses for the Minor in Biological Sciences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>03-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-230/232</td>
<td>Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-240</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Minimum number of units required for the Neuroscience Minor: 63

**Neuroscience Minor**

The curriculum within the Neuroscience minor will allow students from various disciplines to gain fundamental knowledge of neuroscience concepts. The interdisciplinary nature of the coursework echoes the nature of the field itself; students will select courses from the natural, social, and computer sciences. Neuroscientists not only require foundational knowledge of molecular, cellular, and systems neuroscience, but they should also understand the behavioral significance and appreciate how computational work and imaging techniques can aid in clarifying normal and abnormal functioning of these fundamental processes.

Students pursuing the minor in Neuroscience will:

- Acquire foundational knowledge of the basic biological foundations of the nervous system, from the cellular through systems levels.
- Understand the effects of basic neurological function on behavior, including cognition.
- Gain an appreciation of the interdisciplinary nature of the field of neuroscience.

**Distribution Requirements**: Three courses, including at least 1 from each of the following categories:

- Approaches to Neuroscience Category
- Approaches to Neuroscience: 03-315 Magnetic Resonance Imaging in Neuroscience
- Approaches to Neuroscience: 03-368 Neural Computation
- Approaches to Neuroscience: 03-386 Computational Models of Neural Systems
- Approaches to Neuroscience: 05-412 Cognitive Modeling
- Approaches to Neuroscience: 05-414 Cognitive Neuropsychology
- Approaches to Neuroscience: 05-419 Introduction to Parallel Distributed Processing
- Approaches to Neuroscience: 05-429 Cognitive Brain Imaging

- Cognitive Neuroscience Category
- Cognitive Neuroscience: 03-356 Developmental Neuroscience
- Cognitive Neuroscience: 15-486 Artificial Neural Networks
- Cognitive Neuroscience: 85-211 Cognitive Psychology
- Cognitive Neuroscience: 85-370 Perception
- Cognitive Neuroscience: 85-390 Human Memory
- Cognitive Neuroscience: 85-406 Autism: Psychological and Neuroscience Perspectives

- Human Biology Category
- Human Biology: 03-121 Modern Biology
- Human Biology: 03-230 Biochemistry I
- Human Biology: 03-240 Cell Biology

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Transfer credit for Modern Biology

Students wishing to transfer credit for 03-121 Modern Biology from another institution must meet the following requirements:

1. The course in question should have at least an 80% match in topics with 03-121. Topics in 03-121 cover the genetic, molecular, cellular, developmental, and evolutionary mechanisms that underlie biological processes and include: Cell theory; Cell chemistry; Cell structure; Function and structure of proteins, DNA, RNA, lipids and carbohydrates; Cell respiration and fermentation; The cell cycle; Cell-cell interactions and communication; Transcription; Translation; RNA processing in Eukaryotes; DNA replication; DNA mutation and repair; Meiosis; Mitosis; and Regulation of Gene Expression.

This information is sometimes available in the course description, but more detail is often found in a course syllabus.

3. Introductory level courses that focus on other biology areas (i.e. anatomy, physiology, ecology, evolution, and/or development) will not be accepted for 03-121 credit. These courses may receive credit for a general biology elective.

4. Students should contact their departmental academic advisor for the transfer credit approval process in their college.

Faculty

ERIC T. AHRENS, Professor – Ph.D., University of California, Los Angeles; Carnegie Mellon, 2000–.

ALISON L. BARTH, Associate Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2002–.

DANIEL BRASIER, Lecturer – Ph.D., University of California, San Diego; Carnegie Mellon, 2012–.

MAGGIE BRAUN, Assistant Teaching Professor and Assistant Department Head for Undergraduate Affairs – Ph.D., University of Pittsburgh; Carnegie Mellon, 2008–.

AMY L. BURKERT, Teaching Professor and Vice Provost for Education – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997–.

JUSTIN C. CROWLEY, Assistant Teaching Professor and Director of the Health Professions Program – Ph.D., Duke University; Carnegie Mellon, 2003–.

CARRIE B. DOONAN, Teaching Professor – Ph.D., University of Connecticut; Carnegie Mellon, 1993–.

EMILY DRILL, Lecturer – Ph.D., University of Pittsburgh; Carnegie Mellon, 2012–.

M. DANNIE DURAND, Associate Professor – Ph.D., Columbia University; Carnegie Mellon, 2000–.

CHARLES A. ETTENSOHN, Professor – Ph.D., Yale University; Carnegie Mellon, 1987–.

ARYN GITIS, Assistant Professor – Ph.D., University of California, San Diego; Carnegie Mellon, 2012–.

ERIC W. GROTZINGER, Teaching Professor and Associate Dean of Undergraduate Affairs for MCS – Ph.D., University of Pittsburgh; Carnegie Mellon, 1979–.

DAVID D. HACKNEY, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 1978–.

VERONICA F. HINMAN, Associate Professor – Ph.D., University of Queensland; Carnegie Mellon, 2006–.

CHIEN HO, Professor and Director of NMR Center of Pittsburgh – Ph.D., Yale University; Carnegie Mellon, 1979–.

JEFFREY O. HOLLINGER, Professor of Biological Sciences and Biomedical Engineering – Ph.D., D.D.S., University of Maryland; Carnegie Mellon, 2000–.

JONATHAN W. JARVIK, Associate Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978–.

LINDA R. KAUFFMAN, Teaching Professor – Ph.D., University of Pittsburgh; Carnegie Mellon, 1977–.

SANDRA KUHLMAN, Assistant Professor – Ph.D., University of Kentucky; Carnegie Mellon, 2012–.

FREDERICK LANNI, Associate Professor – Ph.D., Harvard University; Carnegie Mellon, 1982–.

CHRISTINA H. LEE, Associate Professor – Ph.D., University of California, San Francisco; Carnegie Mellon, 2000–.

ADAM D. LINSTEDT, Professor – Ph.D., University of California, San Francisco; Carnegie Mellon, 1995–.

A. JAVIER LOPEZ, Associate Professor – Ph.D., Duke University; Carnegie Mellon, 1989–.

MARK R. MACBETH, Assistant Professor – Ph.D., University of Chicago; Carnegie Mellon, 2007–.

BROOKE M. MCCARTNEY, Associate Professor – Ph.D., Duke University; Carnegie Mellon, 2003–.

C. JOEL MCMANUS, Assistant Professor – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–.

JONATHAN S. MINDEN, Professor – Ph.D., Albert Einstein College of Medicine; Carnegie Mellon, 1990–.

AARON P. MITCHELL, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2008–.

ROBERT F. MURPHY, Professor of Biological Sciences and Department Head of Computational Biology – Ph.D., California Institute of Technology; Carnegie Mellon, 1983–.

JOHN F. NAGLE, Professor of Biological Sciences and Physics – Ph.D., Yale University; Carnegie Mellon, 1967–.

MANOJKUMAR PUTHENVEEDU, Assistant Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2009–.

GORDON S. RULE, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996–.

RUSSELL S. SCHWARTZ, Associate Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002–.

V. EMILY STARK, Associate Teaching Professor and Assistant Department Head for Departmental Affairs – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003–.

JOSEPH P. SUHAN, Lecturer – M.A., Hofstra University; Carnegie Mellon, 1989–.

NATHAN N. URBAN, Professor and Department Head – Ph.D., University of Pittsburgh; Carnegie Mellon, 2002–.

LINDA VISOMIRSKI-ROBIC, Lecturer – Ph.D., Case Western Reserve University; Carnegie Mellon, 2003–.

ALAN S. WAGGONER, Professor and Director of MBIC – Ph.D., University of Oregon; Carnegie Mellon, 1999–.

JAMES F. WILLIAMS, Professor – Ph.D., University of Toronto; Carnegie Mellon, 1976–.

JOHN L. WOOLFORD JR., Professor and Co-Director of CNASt – Ph.D., Duke University; Carnegie Mellon, 1979–.

Affiliated Faculty

BRUCE A. ARMITAGE, Professor of Chemistry and Co-Director of CNASt – Ph.D., University of Arizona; Carnegie Mellon, 1997–.

ZIV BAR-JOSEPH, Associate Professor of Computer Science and Machine Learning – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2003–.

PHIL G. CAMPBELL, Research Professor at the Institute for Complex Engineering Systems – Ph.D., Pennsylvania State University; Carnegie Mellon, 1999–.

KRIS DAHL, Assistant Professor of Biomedical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006–.

WILLIAM F. EDDY, Professor of Statistics – Ph.D., Yale University; Carnegie Mellon, 1976–.

ALEX EVILEVITCH, Associate Professor of Physics – Ph.D., Lund University; Carnegie Mellon, 2009–.

T.D. JACOBSEN, Assistant Director and Principal Research Scientist at the Hunt Institute for Botanical Documentation – Ph.D., Washington State University; Carnegie Mellon, 1979–.

ROBERT W. KIGER, Distinguished Service Professor and Botany Professor and the History of Science Director and Principal Research Scientist for the Hunt Institute for Botanical Documentation – Ph.D., University of Maryland; Carnegie Mellon, 1974–.

CHRISTOPHER J. LANGMEAD, Assistant Professor of Computer Science – Ph.D., Dartmouth College; Carnegie Mellon, 2004–.

PHILIP R. LEDUC, Associate Professor of Mechanical Engineering – Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002–.

CARL R. OLSON, Professor of the CNBC – Ph.D., University of California, Berkeley; Carnegie Mellon, 2003–.

CHRISTOPHER J. LANGMEAD, Assistant Professor of Computer Science – Ph.D., University of California, Berkeley; Carnegie Mellon, 1999–.

ROBERT F. MURPHY, Professor of Biological Sciences and Department Head of Computational Biology – Ph.D., California Institute of Technology; Carnegie Mellon, 1983–.

JOHN F. NAGLE, Professor of Biological Sciences and Physics – Ph.D., Yale University; Carnegie Mellon, 1967–.
Adjunct Faculty

JON W. JOHNSON, Professor of Neuroscience at the University of Pittsburgh – Ph.D., Stanford University; Carnegie Mellon, 2006–.

KARL KANDLER, Professor of Otolaryngology and Neurobiology at the University of Pittsburgh – Ph.D., University of Tubingen, Germany; Carnegie Mellon, 2006–.

CYNTHIA LANCE-JONES, Associate Professor of Neurobiology at the University of Pittsburgh – Ph.D., University of Massachusetts; Carnegie Mellon, 2006–.

CYNTHIA M. MORTON, Associate Curator and Head of Botany at the Carnegie Museum of Natural History – Ph.D., New York Botanical Garden/CUNY; Carnegie Mellon, 2002–.

PETER L. STRICK, Co-Director of CNBC and Distinguished Professor of Neurobiology at the University of Pittsburgh – Ph.D., University of Pennsylvania; Carnegie Mellon, 2000–.

D. LANSING TAYLOR, President and Chief Executive Officer of Cellumen, Inc. – Ph.D., State University of New York at Albany; Carnegie Mellon, 1982–.

EDDA THIELS, Assistant Professor of Neurobiology at the University of Pittsburgh – Ph.D., Indiana University; Carnegie Mellon, 2006–.

GEORGE S. ZUBENKO, Professor of Psychiatry at the University of Pittsburgh – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984–.

Emeriti Faculty

PETER B. BERGET, Professor Emeritus – Ph.D., University of Minnesota; Carnegie Mellon, 1986–.

WILLIAM R. MCCLURE, Professor Emeritus – Ph.D., University of Wisconsin; Carnegie Mellon, 1981–.

C. ROY WORTHINGTON, Professor Emeritus – Ph.D., Adelaide University; Carnegie Mellon, 1969–.
Department of Chemistry

Hyung J. Kim, Head
Karen H. Stump, Director of Undergraduate Studies
Office: Doherty Hall 1316
http://www.chem.cmu.edu

Carnegie Mellon provides a family-like but very vibrant and interdisciplinary environment for science students. One of our major strengths is that most of our undergraduate students in chemistry and related fields get involved in research in faculty labs early on and get hands-on experience in cutting-edge research, some even as freshmen. Our curriculum is both fluid and innovative to give students broad background and in-depth knowledge in chemistry and interdisciplinary areas. — Dr. Hyung J. Kim

Chemistry is a science of great power. The discovery of new ways to understand and manipulate matter has contributed to our society in extraordinary ways. Chemistry is the study of matter and the chemical reactions that constitute the processes of nature. It is a science of discovery, and provides the foundation for many other fields that help us understand the world around us and solve pressing problems. Chemistry is a central science, with applications in all aspects of our lives and in all other sciences. It is an experimental science, and its methods involve observation, measurement, prediction, and control. Chemistry underpins our understanding of the relationships between structure and function at the molecular level. Chemistry is the science of life. Chemistry is fundamentally an experimental science, and the different subdisciplines of chemistry relate to and underlie every other non-technical area as well. It is possible to have all of the technical requirements completed after the junior year in both degree programs, allowing students the flexibility to combine electives in the senior year into a focused program of specialization. Students interested in graduate studies in chemistry may enroll in graduate lecture courses. Those desiring immediate job placement may be interested in one or more of the formal options that supplement the chemistry B.S. degree. These are described in detail later. Carnegie Mellon has one of the strongest polymer science programs in the world and the undergraduate polymer science option offers training that is particularly valuable for an industrial career. The Computational Chemistry track provides students with expertise in scientific computing that is highly sought after by employers in the pharmaceutical industry.

An honors program is offered for highly motivated undergraduates. It is designed primarily for students who wish to undertake a strong research-intensive program of study in contemporary chemistry. The program B.S. in Chemistry with Department Honors requires the completion of at least one undergraduate level course in chemistry, a research project, and the writing of a bachelor’s honors thesis. An advanced track leading to the B.S. in Chemistry with Departmental Honors together with a Masters Degree in Chemistry involves completion of five graduate level courses and a more extensive thesis research project. This track is especially attractive to students who have earned advanced placement credit in one or more science and/or mathematics courses at Carnegie Mellon. With enough advanced placement credit or by carrying heavier-than-usual course loads, students can complete the Honors/M.S. degree program in 8 semesters.

Additional majors (double majors) are available with nearly all other departments provided the student can fit the required courses into the schedule. Generally, all the requirements for both departments must be met for an additional major (except for some courses with similar content). Students interested in biochemistry, for example, could pursue a B.S. in Chemistry with an Additional Major in Biological Sciences. Programs are also available that lead to the degree B.S. in Chemistry with a minor in another discipline such as biological sciences, physics, mathematics, computer science, engineering studies, business administration and certain departments in the H&SS (Humanities and Social Sciences) college. Requirements for most minor programs are described by individual departments in this catalog. However, it is recommended that students who are interested in pursuing a minor as part of their degree consult with the department involved for current requirements and further guidance. Dual degree programs are available in which students receive two separate undergraduate degrees from two different departments in the University. These require students to complete at least 60 units of work per additional degree in addition to the units required for the first degree. Several five-year programs have been developed to allow a Carnegie Mellon undergraduate student to earn both a B.S. in Chemistry and a Master of Science degree in fields such as Health Care Policy and Management or Biotechnology Management. Study abroad exchange programs are available for chemistry majors and programs of one to two semesters can generally be accommodated without delaying time to graduation beyond 8 semesters. One example of a formal exchange program is spending two semesters at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. A language program of 3 months duration during the summer is available to students at no extra tuition cost. Study abroad is encouraged by the chemistry department and also can be arranged on an individual basis at universities throughout the world including Europe, Asia, Africa, New Zealand, and Australia during both the academic year and the summer. Some students also participate in short term study abroad experiences during winter or spring break for example. Students interested in study abroad should consult with their academic advisor and the University’s Study Abroad Advisor.

One of the most attractive features of the Department of Chemistry is the opportunity for students to interact with prominent research scientists in entry-level as well as advanced courses and in research. Since the spring of 2003, undergraduate laboratory instruction takes place in a new state-of-the-art facility located in Doherty Hall. Participation in undergraduate research is encouraged and qualified students may begin projects as early as their second year. Chemistry majors interested in beginning research should consult with the Director of Undergraduate Studies to begin the process of identifying a research mentor. Approximately 85 to 95% of the graduating chemistry majors have taken part in research either for pay or for credit as part of their undergraduate training. Chemistry majors have been very successful in obtaining Small Undergraduate Research Grants (SURG) from the University to help support their research projects. Undergraduate and research laboratories are equipped with the latest scientific instrumentation. The use of computers is emphasized throughout the curriculum.

Program Outcomes

The faculty members of the Department of Chemistry have approved the following as a statement of our learning outcomes for recipients of an undergraduate degree in chemistry.

Upon graduation recipients of the BS or BA degree in Chemistry will:

Foundational knowledge/theory

• Have a firm foundation in the quantitative and computational thinking skills underlying chemistry, including use of modern computational tools.
• Have a firm foundation in the theories and models that form the basis for reasoning about molecular systems.
• Understand how the different subdisciplines of chemistry relate to and complement one another.
• Be able to apply chemical reasoning across disciplines, such as biology, environmental science, materials science, nanotechnology, and engineering.

Practical/Experimental

• Understand that chemistry is fundamentally an experimental science, and be able to identify or create an appropriate model, formulate a hypothesis, choose an appropriate set of tools and techniques, and
design an experiment that tests the hypothesis and analyze the results from that experiment drawing sound scientific conclusions from the results obtained.

- Be proficient in the use of both classical and modern tools for analysis of chemical systems.
- Be able to design and carry out synthesis of both organic and inorganic systems.
- Be able to use experience and knowledge gained through theoretical and practical design projects to conduct further research.
- Know and follow the proper procedures and regulations for safe handling and use of chemicals and chemical equipment.

Communication

- Be able to convey information, both orally and in writing, to a range of audience levels and for a variety of purposes.
- Understand how scientific information is shared between peers in modern science, including responsible conduct for acknowledging prior and current contributions.
- Be able to locate, identify, understand and critically evaluate the chemical literature.
- Have developed the interpersonal skills to function cooperatively in a team setting.

Society and ethics

- Understand the opportunities and consequences of chemistry for the environment and society for both the short term and for long-term sustainability.
- Understand and apply ethics and values to all professional activities.

Professional development

- Have developed an understanding of career opportunities both within and outside of chemistry, including through contacts with faculty, the career and professional development center and alumni.
- Feel prepared to pursue a life and career that builds on their experiences at Carnegie Mellon to achieve their personal goals and to contribute positively to society.

B.S. in Chemistry

The majority of undergraduate degrees awarded by the Department of Chemistry are Bachelor of Science degrees. This degree program provides the most appropriate preparation for further graduate study and for research and development or analytical positions in industry. The curriculum provides a strong foundation in the fundamental areas of study in chemistry: organic, physical, inorganic and analytical chemistry, along with a rich set of research-focused, instrumentation intensive laboratory experiences aligned with those areas. Students interested in less technical areas of employment or graduate study in areas such as business, policy or law may find the Bachelor of Arts degree a more suitable alternative.

Curriculum - B.S. in Chemistry (and additional major in chemistry)

The MCS curriculum requires seven Science Core Courses to be completed by the end of the junior year. These are: 21-120 Differential and Integral Calculus, 21-122 Integration, Differential Equations and Approximation, 33-111 Physics I for Science Students, 33-112 Physics II for Science Students, 09-105 Introduction to Modern Chemistry I, 03-121 Modern Biology, and 15-110 Principles of Computing in the sample curriculum given below for chemistry majors, six of these are in the first year. Students should take the last Science Core Course as early as possible and if possible by the end of their sixth semester. Course 09-106 Modern Chemistry II is defined as a Technical MCS Elective.

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-105</td>
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</tr>
<tr>
<td>21-120</td>
<td>10</td>
</tr>
<tr>
<td>33-111</td>
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<tr>
<td>76-101</td>
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<td>99-101</td>
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Spring

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<tr>
<th>Units</th>
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Sophomore Year

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<tr>
<td>09-219</td>
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<td>09-221</td>
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<tr>
<td>03-121</td>
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<td>09-321</td>
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<tr>
<td>09-344</td>
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<tr>
<td>15-110</td>
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Junior Year

<table>
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<td>09-321</td>
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<td>09-345</td>
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<tr>
<td>09-331</td>
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<tr>
<td>xx-xxx</td>
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</table>

Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-401</td>
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<tr>
<td>xx-xxx</td>
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<tr>
<td>xx-xxx</td>
<td>27</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>9</td>
</tr>
</tbody>
</table>

This fall semester is challenging with 4 required chemistry classes. There are ways to alleviate the load by moving classes into the senior year. 09-321 could be moved to the fall of the senior year. 09-331 and/or 09-344 can be moved into the fall of the senior year. However both classes are prerequisites for 09-322 Laboratory IV: Molecular Spectroscopy and Dynamics, so delaying either would move 09-322 to the second semester of the senior year. It is best to discuss your options with your advisor in order to craft a plan that is best for you.

Spring

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
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Spring

<table>
<thead>
<tr>
<th>Units</th>
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<tr>
<td>3</td>
</tr>
<tr>
<td>36</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>

Certain non-technical courses from Business Administration, Heinz College, and EPP also may be used to fulfill the non-technical elective requirement. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cm.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. For example accounting, finance, production, and statistics courses may NOT be used. Also, 65-219 Biological Foundations of Behavior may NOT be used as an elective in the H&SS/CFA category. If in doubt, check with your advisor.
Distribution of Units for the B.S. Degree and Requirements for An Additional Major in Chemistry

Minimum Total Chemistry Units 163; See distribution below

**Required Chemistry Courses** Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-204</td>
<td>Professional Communication Skills in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-219</td>
<td>Modern Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-220</td>
<td>Modern Organic Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-331</td>
<td>Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>09-332</td>
<td>Modern Analytical Instrumentation</td>
<td>9</td>
</tr>
<tr>
<td>09-344</td>
<td>Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-345</td>
<td>Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-348</td>
<td>Inorganic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-222</td>
<td>Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-321</td>
<td>Laboratory III: Molecular Design and Synthesis</td>
<td>12</td>
</tr>
<tr>
<td>09-322</td>
<td>Laboratory IV: Molecular Spectroscopy and Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>09-xxx</td>
<td>Chemistry Seminars</td>
<td>8</td>
</tr>
<tr>
<td>09-xxx</td>
<td>Chemistry Electives</td>
<td>18</td>
</tr>
</tbody>
</table>

* These, plus 33-111 Physics I for Science Students and 33-112 Physics II for Science Students, are the required courses for students earning an additional major in chemistry.

09-107 Honors Chemistry: Fundamentals Concepts and Applications, may be taken instead of 09-105.

Students who transfer into the department and have taken 09-217 Organic Chemistry I and/or 09-218 Organic Chemistry II, will be required to complete units of 09-435 Independent Study Chemistry, 1 unit per course, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Chemistry courses required for the BS degree and the additional major in chemistry that are numbered 09-2xx or higher must be taken at Carnegie Mellon University. Exceptions must be requested of and approved by the Director of Undergraduate Studies. In general such requests will be approved only under unusual or extenuating circumstances.

**Other Requirements**

<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Biology</td>
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<tr>
<td>Computer Science</td>
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</tr>
<tr>
<td>Mathematics</td>
<td>20</td>
</tr>
<tr>
<td>Physics</td>
<td>24</td>
</tr>
<tr>
<td>Humanities and Social Sciences</td>
<td>72</td>
</tr>
<tr>
<td>Fine Arts courses</td>
<td>61</td>
</tr>
<tr>
<td>Free Electives</td>
<td>3</td>
</tr>
</tbody>
</table>

Minimum number of units required for 360 the degree:

The above B.S. curriculum recommends a range of 40-51 units/semester to meet the minimum degree requirement. Students are strongly encouraged to take extra elective courses (except in the first semester of the freshman year) in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

**Notes on Electives**

Chemistry Electives

A minimum of 18 units of chemical electives is required.

Chemistry electives can be satisfied by 09-445 Undergraduate Research, or by most other chemistry courses 09-xxx or higher, undergraduate or graduate level, for which the student has the necessary prerequisites, or 03-231/232 Biochemistry. 09-435 Independent Study Chemistry may only be used to fulfill this requirement with permission of the Director of Undergraduate Studies. Certain interdisciplinary courses (e.g. 39-xxx) relating to chemistry can also be used. The scheduling of these electives can vary and students should check with the department offering the course to see which courses are offered in any given year or semester and with the Director of Undergraduate Studies in the Department of Chemistry to ascertain whether the course is an acceptable chemistry elective.

**Free Electives**

Free electives are defined as including any course offered by Carnegie Mellon except those in science or engineering fields that are primarily intended for non-majors. A maximum of 9 units total of Physical Education, StuCo and/or ROTC courses can be counted as free elective units. The Chemistry Department does not require technical electives.

**Options for the B.S. in Chemistry**

The curriculum for the degree Bachelor of Science in Chemistry permits students to take a number of elective courses in chemistry and other fields, particularly in the junior and senior years. Students may wish to complete a group of elective courses from several specialty areas, called "options," to complement their technical education. Each option will complement the Bachelor's degree in Chemistry and will provide students with expertise in a specific area not covered by the normal undergraduate curriculum. Options are noted on the student's transcript but not on the diploma.

For each of the following options, the student should refer to the previous description of the curriculum for the B.S. in Chemistry. Required courses are unchanged, and the courses that should be taken as electives for each option are listed below. Chemistry courses within an option also count towards fulfillment of the chemistry elective requirement for the B.S. degree.

A student who completes the recommended courses for any of these options will receive a certificate from the Department of Chemistry at Commencement as formal evidence of the accomplishment and a notation of this will be made on the student's transcript.

**BIOCHEMISTRY OPTION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Biochemistry I</th>
<th>Genetics</th>
<th>Experimental Biochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

**FREE ELECTIVE COURSE MAY BE CHOSEN FROM THE FOLLOWING LIST**

<table>
<thead>
<tr>
<th>Units</th>
<th>Introduction to Biophysics</th>
<th>Biogeochemistry: Nucleic Acids and Carbohydrates</th>
<th>Biogeochemistry: Peptides, Proteins and Combinatorial Chemistry</th>
<th>Applied topics in Macromolecular and Biophysical Techniques</th>
<th>Advanced Biochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
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</tbody>
</table>

**POLYMER SCIENCE OPTION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Experimental Polymer Science</th>
<th>Organic Chemistry of Polymers</th>
<th>Physical Chemistry of Macromolecules</th>
<th>Elective in Polymer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
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</table>

**FREE ELECTIVE COURSE MAY BE CHOSEN FROM THE FOLLOWING LIST**

<table>
<thead>
<tr>
<th>Units</th>
<th>Polymer Science</th>
<th>Undergraduate Research (in a polymer area as approved by the Director of Undergraduate Studies)</th>
<th>Introduction to Polymer Science and Engineering</th>
<th>Molecular and Micro-scale Polymeric Biomaterials in Medicine</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
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<td>-1</td>
<td>9</td>
<td>9</td>
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</table>

**MATERIALS CHEMISTRY OPTION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Engineering the Materials of the Future</th>
<th>Structure of Materials</th>
<th>Two Electrolyte Courses of at least 9 units each from the list below</th>
<th>Defects in Materials</th>
<th>Undergraduate Research (in a materials area as approved by the Director of Undergraduate Studies)</th>
<th>Organic Chemistry of Polymers</th>
<th>Physical Chemistry of Macromolecules</th>
<th>Polymer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>9</td>
<td>9</td>
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<td>9</td>
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</table>

**FREE ELECTIVE COURSE MAY BE CHOSEN FROM THE FOLLOWING LIST**

<table>
<thead>
<tr>
<th>Units</th>
<th>Undergraduate Research (in a materials area as approved by the Director of Undergraduate Studies)</th>
<th>Organic Chemistry of Polymers</th>
<th>Physical Chemistry of Macromolecules</th>
<th>Polymer Science</th>
</tr>
</thead>
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<td>9</td>
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</table>

**ENVIRONMENTAL CHEMISTRY OPTION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Introduction to Green Chemistry</th>
<th>Three-course sequence of at least 9 units each from the list below</th>
<th>Energy and the Environment</th>
<th>Environmental Decision Making</th>
<th>Combustion and Air Pollution Control</th>
<th>Introduction to Civil and Environmental Engineering</th>
<th>Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods</th>
<th>Atmospheric Chemistry, Air Pollution and Global Change</th>
<th>Climate and Energy: Science, Economics, and Public Policy</th>
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</thead>
<tbody>
<tr>
<td>9</td>
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**FREE ELECTIVE COURSE MAY BE CHOSEN FROM THE FOLLOWING LIST**

<table>
<thead>
<tr>
<th>Units</th>
<th>Water Resources Engineering</th>
<th>Air Quality Engineering</th>
<th>Air Quality Engineering</th>
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**MANAGEMENT OPTION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Economics</th>
<th>Introduction to Business Management</th>
<th>Introduction to Accounting</th>
<th>Business Law</th>
</tr>
</thead>
<tbody>
<tr>
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**FREE ELECTIVE COURSE MAY BE CHOSEN FROM THE FOLLOWING LIST**

<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Economics</th>
<th>Introduction to Business Management</th>
<th>Introduction to Accounting</th>
<th>Business Law</th>
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<tr>
<td>9</td>
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</table>
A student who completes the recommended courses for any of these options will receive a certificate from the Department of Chemistry at the department Commencement Ceremony as formal evidence of the accomplishment and a notation of this will be made on the student’s transcript.

B.S. in Chemistry with Departmental Honors

Outstanding students with an interest in research are encouraged to consider the Honors program by the beginning of the junior year. The program combines a modified B.S. curriculum with close faculty-student contact in an individual research project, concluding with the student’s presentation and defense of a bachelor’s honors thesis to a Thesis Committee.

The B.S. in Chemistry with Departmental Honors curriculum follows the general sequence of courses that is listed for the B.S. degree. Students are strongly urged to complete all seven of the Science Core Courses as early as possible. The honors program specifies that one of the two chemistry electives be a 12-unit graduate course, and that of the remaining electives required, at least two be undergraduate research (18 units) and one be 09-445 Honors Thesis (taken for 6 units). Students will be encouraged to do more than the minimum amount of research, so stipends from the research advisor or other sources are sometimes available for summer B.S. honors research.

At any time before the spring term of the senior year, candidates for the B.S. in chemistry may apply to be admitted to the Honors B.S. program. Applications are available through the Director of Undergraduate Studies. To be accepted, students will be expected to have shown excellent performance in class work – normally at least a 3.2 average QPA. Upon acceptance into the program, a Thesis Committee must be identified, which will monitor the progress of the student. The committee shall consist of at least one member of the Honors Committee, the student’s research advisor and a third faculty member agreed upon by the student and advisor. This third member can be from another department or institution and can be tenure track, teaching track or research track faculty. It is the student’s responsibility to contact the proposed members of their committee and confirm their participation.

A written thesis suitable for an Honors B.S. degree is required and should be a clear exposition in proper scientific format of a research project done for at least 18 units of credit in 09-445 Undergraduate Research. The student’s Thesis Committee will evaluate the thesis and will require that each student participate in a public oral presentation or defense of the thesis before it approves the Honors degree. The written thesis must be supplied to the members of the student’s Thesis Committee no later than 1 week prior to the scheduled public defense. The defense is usually scheduled to take place during April or early May of the senior year and the Director of Undergraduate Studies will coordinate the selection of a suitable date. Students completing the B.S. with Departmental Honors in Chemistry will receive MCS College Honors as well.

The designations of MCS College Honors and Departmental Honors are noted on the transcript but not on the diploma. Only University Honors are noted on the diploma.

Honors B.S./M.S. Program in Chemistry

Outstanding students seeking an advanced degree are encouraged to apply for admission to the B.S./M.S. Honors program as early as they can but only after having made some progress on a research project that could eventually be suitable for production of a Master’s level thesis. Please note that this degree is available only with the B.S. in chemistry and cannot be obtained by students pursuing a B.A. degree in chemistry. Most commonly, applications are submitted during the second half of the sophomore year or during the junior year. Applications are available through the Director of Undergraduate Studies. Participants will have the opportunity to earn in four years not only the degree B.S. in Chemistry with Departmental Honors, but also the degree Master of Science in Chemistry. This program is highly research intensive and is not appropriate for all students. Requirements include completing five graduate level courses as electives. (See notes on Honors B.S./M.S. electives.)

The schedule of courses for the B.S./M.S. program generally moves as many courses as possible forward in the curriculum, though this is not a requirement. When possible, all Science Core Courses should be completed in the freshman year. This gives the student the following advantages: 1) greater perspective in selection of a research advisor, 2) greater maturity in performing independent research, and 3) the possibility of initiating graduate course sequences in the junior year. Students can achieve this accelerated schedule through advanced placement and summer school.

Upon acceptance into the program, a Thesis Committee must be identified, which will monitor the progress of the student. The committee shall consist of one Honors Committee, the student’s research advisor and a third faculty member agreed upon by the student and advisor. This third member can be from another department or institution and can be tenure track, teaching track or research track faculty. It is the student’s responsibility to contact the proposed members of their committee and confirm their participation.

The student is expected to keep the research advisor selected by May of the sophomore year for the duration of the thesis project. Summer thesis research for 10 weeks after the sophomore and junior years is strongly suggested to assist the student in completing research of sufficient quantity and quality to complete their thesis. Students normally will be given stipends for their summer work either by their research advisor or by competing for a summer fellowship. A minimum of 3 semesters of undergraduate research is required (normally 10 units/semester) as participation in group seminars during the junior and senior years. Students must present their research at least once at the Sigma Xi competition at Meeting of the Minds, the annual Carnegie Mellon undergraduate research symposium, typically at the end of the junior year. In addition students must meet with their Thesis Committee each fall to update the committee on their progress and in the fall of the senior year must prepare a written summary of their research progress to date (5 pages) and their plans for the academic year (1 page). This report must state clearly what the stage the work is in; it must be clear which work is complete and ready for publication.

At the start of the spring semester of the senior year, the student must submit a draft of the introduction for their thesis and a detailed outline of their methods, results and discussion sections to the Director of Undergraduate Studies who also chairs the Honors Committee. This will be distributed by the department and reviewed by the student’s Thesis Committee.

Each student is required to submit a formal Masters Degree dissertation to the Chemistry Department in April of the senior year or at least one week prior to the date set for the thesis defense. The Thesis Committee will evaluate the written thesis and students are required to present their final oral defense of the project before the Thesis Defense Committee. The defense is usually scheduled to take place during April or early May of the senior year and the Director of Undergraduate Studies will coordinate the selection of a suitable date. The public defense is followed by a private question and answer session with the Thesis Committee.

The dissertation, written in proper scientific format, should describe the research project in considerable detail and must satisfy the majority of the requirements of the Thesis Committee with respect to completeness. It need not be as extensive nor contain the element of student originality characteristic of a Ph.D. thesis; however it must contain results and conclusions that are of a high enough quality to be accepted as a publication in a respected research journal. The student should refer to the ACS Style Guide for recommendations on appropriate presentation and formatting of written text, tables, graphs, and figures. As for all M.S. degree candidates in the Department, the dissertation must be approved by the faculty member in charge of the work.

Research productivity is the most important criterion for success at the evaluation points, but QPA is a strong secondary criterion. While we expect that most students will maintain a QPA of 3.5, a minimum of 3.2 must be maintained to remain in the program and will be acceptable only with a strong record of research. Candidates must also maintain a QPA of at least 3.0 in the five graduate level courses required for the degree.

Students who complete this program will receive the designations of Departmental Honors and MCS College Honors. These are designated on the transcript, not on the diploma. Only University Honors are denoted on the diploma.

Students completing the requirements for this degree receive two diplomas, one for the B.S. degree and another for the M.S. degree.

Notes on Honors B.S./M.S. Electives

The B.S./M.S. Honors degree requires the completion of five graduate level courses. These normally are 12-unit courses. However, in order not to penalize interdisciplinary studies which may be essential to a good thesis, up to three of the five required graduate chemistry courses may...
be advanced undergraduate (9-unit) courses in MCS and/or approved CIT departments. All advanced undergraduate level courses used to satisfy this requirement must be approved by the Director of Undergraduate Studies.

Curriculum - B.S. with Departmental Honors / M.S. in Chemistry

First Year

Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>76-101 Interpreting and Argument</td>
<td>9</td>
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<td>99-101 Computing @ Carnegie Mellon</td>
<td>3</td>
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Spring

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>09-219 Modern Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-221 Modern Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-222 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-301 Undergraduate Seminar I</td>
<td>9</td>
</tr>
<tr>
<td>09-302 Undergraduate Seminar II</td>
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Sophomore Year

Fall

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>09-219 Modern Organic Chemistry</td>
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</tr>
<tr>
<td>09-220 Modern Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-301 Undergraduate Seminar I</td>
<td>9</td>
</tr>
<tr>
<td>09-302 Undergraduate Seminar II</td>
<td>9</td>
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Spring

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-204 Professional Communication Skills in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-220 Modern Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-301 Undergraduate Seminar I</td>
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</tr>
<tr>
<td>09-302 Undergraduate Seminar II</td>
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</table>

Summer

10 weeks Honors Research recommended

Junior Year

Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-301 Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>09-231 Laboratory III: Molecular Design and Synthesis</td>
<td>12</td>
</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-331 Modern Analytical instrumentation</td>
<td>9</td>
</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 1 (of 4)</td>
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Spring

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-302 Undergraduate Seminar IV</td>
<td>1</td>
</tr>
<tr>
<td>09-322 Laboratory IV: Molecular Spectroscopy and Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>09-445 Undergraduate Research</td>
<td>10</td>
</tr>
<tr>
<td>09-xxx Graduate Chemistry Course (see notes on Honors B.S./M.S. electives)</td>
<td>12</td>
</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 2 (of 4)</td>
<td>9</td>
</tr>
</tbody>
</table>

Summer

10 weeks Honors Research recommended

Senior Year

Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-401 Undergraduate Seminar V</td>
<td>1</td>
</tr>
<tr>
<td>09-445 Undergraduate Research</td>
<td>10</td>
</tr>
<tr>
<td>09-xxx Graduate Chemistry Course</td>
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</table>

Spring

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-402 Undergraduate Seminar VI</td>
<td>3</td>
</tr>
<tr>
<td>09-455 Honors Thesis</td>
<td>15</td>
</tr>
<tr>
<td>09-xxx Graduate Chemistry Course</td>
<td>12</td>
</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 3 (of 4)</td>
<td>9</td>
</tr>
</tbody>
</table>

Certain non-technical courses from Business Administration, Heinz College, and EPP also may be used to fulfill the non-technical elective requirement. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. For example accounting, finance, production, and statistics courses may NOT be used. Also, 85-219 Biological Foundations of Behavior may NOT be used as an elective in the H&SS/CFA category. If in doubt, check with your advisor.

Distribution of Units for the B.S. with Honors/M.S. Degrees

Minimum Total Chemistry Units (250, See distribution below)

<table>
<thead>
<tr>
<th>Required Chemistry Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-204 Professional Communication Skills in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-220 Modern Organic Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-231 Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>09-331 Modern Analytical Instrumentation</td>
<td>9</td>
</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-348 Inorganic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-222 Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-321 Laboratory III: Molecular Design and Synthesis</td>
<td>12</td>
</tr>
<tr>
<td>09-322 Laboratory IV: Molecular Spectroscopy and Dynamics</td>
<td>12</td>
</tr>
</tbody>
</table>

Other Requirements

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Computer Science</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Humanities and Social Sciences or Fine Arts courses</td>
</tr>
<tr>
<td>Computing @ Carnegie Mellon</td>
</tr>
</tbody>
</table>

Minimum number of units required for 388 degrees:

B.A. in Chemistry

The curriculum for the B.A. degree provides students with the opportunity to take a substantial number of elective and non-technical courses. Certain chemistry, math, and other technical courses required for the B.S. degree are replaced by free electives, making this degree an ideal choice for those who wish to earn an additional major with one of the departments in the College of Humanities and Social Sciences, College of Fine Arts, or with the Business Administration program, though this is not a requirement. It is also attractive for students wishing to pursue careers in dentistry or pharmacy, career paths that require a broader preparation at the undergraduate level.
It is not possible to combine the B.A. degree in chemistry with an additional B.A. degree in another department in MCS (e.g., Biological Sciences). Students may earn one or more of the options as described for B.S. degree candidates, providing they complete the courses listed.

The suggested curriculum recommends that the required technical courses be completed at the earliest opportunity, however students have considerable flexibility to postpone these courses in favor of electives, allowing compatibility with the programs of other departments. In designing such programs for a minor or additional major with chemistry, students should note that certain required chemistry courses only are offered in specific semesters, not both. These include the Fall-only courses 09-219 Modern Organic Chemistry and 09-321 Laboratory III: Molecular Design and Synthesis and the Spring-only courses 09-214 Physical Chemistry, 09-220 Modern Organic Chemistry II, 09-348 Inorganic Chemistry, and 09-204 Professional Communication Skills in Chemistry. Also, in some cases, a course that is normally scheduled for the fall may be changed to a spring course (or the inverse) due to a departmental curriculum change.

Curriculum - B.A. in Chemistry

First Year

Fall Units
09-105 Introduction to Modern Chemistry I 10
21-120 Differential and Integral Calculus 10
33-111 Physics I for Science Students 12
76-101 Interpretation and Argument 9

Spring Units
09-106 Modern Chemistry II 10
21-122 Integration, Differential Equations and Approximation 10
33-112 Physics II for Science Students 12
xx-xxx H&SS Distribution Course I 9
15-110 Principles of Computing 10

44

Students interested in majoring in chemistry should consider enrolling in the 3-unit lab course 09-101 Introduction to Experimental Chemistry, in the Fall or Spring semester of the freshman year. Although not required, the laboratory course is recommended for chemistry majors.

Sophomore Year

Fall Units
09-201 Undergraduate Seminar I 1
09-219 Modern Organic Chemistry 10
09-221 Laboratory I: Introduction to Chemical Analysis 12
xx-xxx Free Elective 9
xx-xxx H&SS Distribution Course 2 9

41

Spring Units
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists 1
09-204 Professional Communication Skills in Chemistry 3
09-220 Modern Organic Chemistry II 10
09-222 Laboratory II: Organic Synthesis and Analysis 12
09-214 Physical Chemistry 9
xx-xxx H&SS Distribution Course 3 9

44

Junior Year

Fall Units
09-301 Undergraduate Seminar III 1
09-321 Laboratory III: Molecular Design and Synthesis 12
03-121 Modern Biology 9
09-xxx Chemistry Elective 9
xx-xxx Free Elective 9
xx-xxx H&SS/CFA Elective 1 (of 4) 9

49

Spring Units
09-302 Undergraduate Seminar IV 1
09-348 Inorganic Chemistry 10
09-xxx Chemistry Elective 9
xx-xxx Free Elective 9
xx-xxx Free Elective 9
xx-xxx H&SS/CFA Elective 2 (of 4) 9

47

Senior Year

Fall Units
09-401 Undergraduate Seminar V 1
xx-xxx Free Electives 36
xx-xxx H&SS/CFA Elective 3 (of 4) 9

46

Spring Units
09-402 Undergraduate Seminar VI 3
xx-xxx Free Electives 28
xx-xxx H&SS/CFA Elective 4 (of 4) 9

40

Certain non-technical courses from Business Administration, Heinz College, and EPP also may be used to fulfill the non-technical elective requirement. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. For example accounting, finance, production, and statistics courses may NOT be used. Also, 85-219 Biological Foundations of Behavior may NOT be used as an elective in the H&SS/CFA category. If in doubt, check with your advisor.

Distribution of Units for the B.A. Degree

Minimum Total Chemistry Units 124; See distribution below:

Required Chemistry Courses Units
09-105 Introduction to Modern Chemistry I 10
09-106 Modern Chemistry II 10
09-204 Professional Communication Skills in Chemistry 3
09-219 Modern Organic Chemistry 10
09-220 Modern Organic Chemistry II 10
09-214 Physical Chemistry 9
or 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry 10
or 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry 10
09-348 Inorganic Chemistry 10
09-221 Laboratory I: Introduction to Chemical Analysis 12
09-222 Laboratory II: Organic Synthesis and Analysis 12
09-321 Laboratory III: Molecular Design and Synthesis 12
09-xxx Chemistry Seminars 8
09-xxx Chemistry Electives 18

09-107 Honors Chemistry: Fundamentals Concepts and Applications, may be taken instead of 09-105.

09-322 Laboratory IV: Molecular Spectroscopy and Dynamics may be taken in lieu of 09-321 Laboratory III: Molecular Design and Synthesis. However the student must complete the necessary pre- and co-requisites of 09-231, 09-344, 09-331 and 09-345.

Students who transfer into the department and have taken 09-217 Organic Chemistry I, and/or 09-218 Organic Chemistry II, will be required to complete units of 09-435 Independent Study in Chemistry, 1 unit per course, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Chemistry courses required for the BA degree that are numbered 09-2xx or higher must be taken at Carnegie Mellon University. Exceptions must be requested of and approved by the Director of Undergraduate Studies. In general such requests will be approved only under unusual or extenuating circumstances.

Other Requirements Units
Biology 9
Computer Science 10
Mathematics 20
Physics 24
Humanities and Social Sciences or Fine Arts courses 72
Free Electives 0
Computing @ Carnegie Mellon 3
Minimum number of units for the degree 360

The above B.A. curriculum recommends an average course load of 40–51 units/semester. The total units will exceed the 360 unit minimum, but students are strongly encouraged to take the extra elective courses in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

Notes on Electives
Chemistry Electives
A minimum of 18 units of chemical electives is required.
Chemical electives can be satisfied by 09-445 Undergraduate Research, or by most other chemistry courses 09-3xx or higher, undergraduate or graduate, for which the student has the necessary prerequisites, or by 03-231/03-232 Biochemistry I. 09-435 Independent Study Chemistry, may only be used to fulfill this requirement with permission of the Director of Undergraduate Studies. Certain interdisciplinary courses (e.g. 39-xxx) relating to chemistry can also be used. The scheduling of these electives can vary and students should check with the department offering the course to see which courses are offered in any given year or semester and with the Director of Undergraduate Studies in the Department of Chemistry to ascertain whether the course is an acceptable chemistry elective.

Free Electives
Free electives are defined as including any course offered by Carnegie Mellon except those in science or engineering fields that are primarily intended for non-majors. A maximum of 9 units total of Physical Education and/or ROTC courses can be counted as free elective units. The Chemistry Department does not require technical electives.

Requirements for a Minor in Chemistry
In order for a student to receive a minor in Chemistry in conjunction with a B.S. or B.A. degree from another (primary) department, the successful completion of six courses as distributed below is required. Students pursuing the minor must inform the Chemistry Department of their intentions in writing using the MCS form for declaration of a minor so that the minor designation can be approved prior to graduation. The form may be obtained in the department office, DH 3137, or from the MCS undergraduate web page, http://www.cmu.edu/mcs/undergrad/advising/forms/index.html. It should be completed and submitted to the Director of Undergraduate Studies no later than the end of the course add period of the final semester prior to graduation. If you decide at a later date not to complete the minor, it would be helpful to notify the Director of Undergraduate Studies so that it can be removed from your record. Minors are listed on the transcript but not on the diploma.

A. Four Required Core Courses
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry 9
09-245 Physical Chemistry 9
09-231 Mathematical Methods for Chemists, does not count towards the minor in chemistry. The undergraduate research courses 09-445
Undergraduate Research and 09-435 Independent Study Chemistry cannot be used for the minor.
Transfer credit will be accepted only for 09-106 and 09-217. All other classes towards the chemistry minor must be completed at Carnegie Mellon University.

Other Programs
As part of the undergraduate degree program, chemistry majors have the opportunity to pursue various special programs at Carnegie Mellon to enrich their academic experience. These include but are not limited to: programs with the College of Fine Arts, Humanities and Social Sciences, the John Heinz College of Public Policy and Management; Interdisciplinary Majors and Minors including Health Care Policy and Management. For more details, see the Tailoring Your Education portion of the Mellon College of Science section in this catalog.

Transfer Credit for Chemistry Courses
1. Requests for transfer credit for chemistry classes taken at other institutions should be made to Karen Stump, the Director of Undergraduate Studies in the Department of Chemistry. Students making such requests should follow the policies and procedures in place within their home colleges in assembling materials for such requests. Consult with your advisor on the appropriate steps.
2. At minimum requests must be accompanied by a complete syllabus including the textbook that will be used, a detailed list of topic areas and an indication of whether or not the course is part of the curriculum for science majors at the other institution.
3. No transfer credit will be awarded for the laboratory classes required for the chemistry major at Carnegie Mellon University, 09-221, 09-321 and 09-322. Requests for transfer credit for 09-101, Introduction to Experimental Chemistry, will be accepted with the appropriate documentation.
4. In assessing the suitability of courses for transfer credit, the following factors are considered:
   • The rigor of the course must be comparable to that offered at Carnegie Mellon. This is usually assessed via the textbook used and the amount of time spent on topic areas.
   • The topic areas should match to a degree of at least 80% those covered in the comparable course at Carnegie Mellon University.
5. 09-105 Introduction to Modern Chemistry I focuses primarily on structure and bonding. Detailed topics include the following:
   • History and Conceptual Basis of Modern Chemistry
   • Radiation, Quantum Mechanics, and Atomic Structure
   • Periodic Table and Trends in Elemental Properties (including discussion of exceptions to trends)
   • Bonding (bond polarity)
   • Lewis Structures (octet rule and exceptions; formal charge)
   • Resonance Structures
   • Molecular shapes
   • Molecular Purity
   • Naming compounds
   • Interparticle (intermolecular) forces and comparing physical properties from them
   • Valence Bond (Localizad Electron) and Molecular Orbital Theory
   • Determining number of moles and chemical formulas
   • Writing and balancing chemical equations (in particular completing combustion and double displacement reactions – including acid-base and precipitation reactions)
   • Stoichiometry – limiting reactant and percentage yield
   • Gases (mainly ideal) and stoichiometric applications involving them
   • Phase transitions
   • Solutions (determining concentrations, dilution problems, stoichiometric applications),
   • Application of solubility rules to determine if a precipitate forms
   • Acid-base reactions and titrations
   • Oxidations Numbers and Redox Reactions/Titrations (including balancing redox reactions)
   • Colligative Properties; Mixtures and Distillation
• Transition Metal Complexes and Crystal Field Theory (including crystal field stabilization energy and optical properties)

6. 09-106 Modern Chemistry II focuses primarily on thermodynamics, kinetics and equilibrium. Detailed topic areas include the following.
• Thermochemistry and Thermodynamics (First, Second, and Third Laws, with gas expansion/compression applications, including reversible, adiabatic processes
• Internal energy, enthalpy, entropy, Gibbs Free energy, and determination of spontaneity
• Kinetics: Determination of rate, order, rate laws (including application of pseudo-rate laws, application of integrated rate law to determine order, relationship between time and amount in a reaction, and half-life
• Reaction mechanisms – applying fast equilibrium and steady-state approximations to determine rate law consistent with mechanism
• Chemical Equilibrium: determination of Q and K expressions, determination of direction in which reaction proceeds to achieve equilibrium (using Q and Le Chatelier’s principles, quantitative calculations to determine K or amounts at various stages, dependence of K on temperature, relationship between Gibbs Free energy, Q, and K
• Acid-Base Equilibria: writing dissociation equilibrium reactions and acid-base “neutralization” reactions, autoionization of water (determination of pH and pOH, use of K_w), writing K_a and K_b expressions from dissociation equilibria, quantitative equilibrium calculations for weak acids and bases, titrations between strong species, strong-weak species, and weak-weak species, buffers (calculations of pH and amounts, including how to make a buffer), polyprotic species (quantitative applications and titrations), solubility and precipitation equilibria, determination of K_sp expressions and quantitative applications of those expressions, complex ion formation equilibria, emphasis is placed on equilibrium problems that involve multiple types of simultaneous equilibria
• Electrochemistry: Electrochemical cell notation and writing half-reactions from it, Faraday constant to connect number of moles of electrons / reaction amounts with current, connection of Gibbs Free Energy to cell voltage (potential) at equilibrium and non-equilibrium conditions, determination of K’s (acid-base, solubility constants) or amounts using Nernst equation in concentration cells (K for cell reaction)

Faculty
CATALINA ACHIM, Professor of Chemistry – Ph.D., Carnegie Mellon; Carnegie Mellon, 2001–.
BRUCE A. ARMITAGE, Professor of Chemistry, Co-Director for Nucleic Acids Science and Technology – Ph.D., University of Arizona; Carnegie Mellon, 1997–.
STEFAN BERNHARD, Associate Professor of Chemistry – Ph.D., University of Fribourg (Switzerland); Carnegie Mellon, 2009–.
MARK E. BIER, Research Professor and Director, Center for Molecular Analysis – Ph.D., Purdue University; Carnegie Mellon, 1996–.
EMILLE BOMINAAR, Associate Research Professor – Ph.D., University of Amsterdam (The Netherlands); Carnegie Mellon, 1994–.
MARCEL P. BRUCHEZ, Associate Professor of Chemistry and Biological Sciences, Associate Director, Molecular Biosensor and Imaging Center – Ph.D., University of California, Berkeley; Carnegie Mellon, 2006–.
TERRENCE J. COLLINS, Teresa Heinz Professor in Green Chemistry, Director, Institute for Green Science – Ph.D., University of Auckland, (New Zealand); Carnegie Mellon, 2007–.
SUBHA R. DAS, Associate Professor of Chemistry – Ph.D., Auburn University; Carnegie Mellon, 2006–.
NEIL M. DONAHUE, Professor of Chemistry, Chemical Engineering and Engineering and Public Policy, Director, Center for Atmospheric Particle Studies – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000–.
REBECCA FREELAND, Associate Dean for Special Projects, Mellon College of Science and Associate Head, Department of Chemistry – Ph.D., Carnegie Mellon; Carnegie Mellon, 1993–.
ROBERTO GIL, Research Professor and Director, NMR Facility – Ph.D., Córdoba National University (Argentina); Carnegie Mellon, 2002–.
SUSAN T. GRAUL, Assistant Teaching Professor – Ph.D., Purdue University; Carnegie Mellon, 1992–.
MICHAEL P. HENDRICH, Professor of Chemistry – Ph.D., University of Illinois; Carnegie Mellon, 1994–.
RONGCHAO JIN, Associate Professor of Chemistry – Ph.D., Northwestern University; Carnegie Mellon, 2006–.
HYUNG J. KIM, Professor of Chemistry and Head, Department of Chemistry – Ph.D., State University of New York at Stony Brook; Carnegie Mellon, 1992–.
TOMASZ KOWALEWSKI, Professor of Chemistry – Ph.D., Polish Academy of Sciences (Poland); Carnegie Mellon, 2000–.
MARIA KURNIKOVA, Associate Professor of Chemistry – Ph.D., University of Pittsburgh; Carnegie Mellon, 2003–.
MIGUEL LUNAS, Professor of Chemistry – Ph.D., University of California at Berkeley; Carnegie Mellon, 1976–.
DANITH LY, Associate Professor of Chemistry – Ph.D., Georgia Tech; Carnegie Mellon, 2001–.
MAUMITA MANDAL, Assistant Professor of Chemistry – Ph.D., Center for Cellular and Molecular Biology (India); Carnegie Mellon, 2008–.
KRZYSZTOF MATYJASZEWSKI, J.C. Warner University Professor of Natural Sciences and Director, Center for Macromolecular Engineering – Ph.D., Polish Academy of Sciences (Poland); Carnegie Mellon, 1986–.
RICHARD D. McCULLOUGH, Thomas Lord Professor of Chemistry and Vice President of Research – Ph.D., Johns Hopkins University; Carnegie Mellon, 1990–.
TERRANCE B. MURPHY, Teaching Professor at Carnegie Mellon University-Qatar – Ph.D., University of Washington; Carnegie Mellon, 2008–.
ECKARD MÜNCK, Professor of Chemistry – Ph.D., Technical University of Darmstadt, (Germany); Carnegie Mellon, 1990–.
KEVIN NOONAN, Assistant Professor of Chemistry – Ph.D., University of British Columbia (Canada); Carnegie Mellon, 2011–.
GARY D. PATTERSON, Professor of Chemistry – Ph.D., Stanford University; Carnegie Mellon, 1984–.
LINDA A. PETEANU, Professor of Chemistry – Ph.D., University of Chicago; Carnegie Mellon, 1992–.
GLORIA SILVA, Assistant Teaching Professor – Ph.D., Universidad Nacional de Córdoba (Argentina); Carnegie Mellon, 2002–.
KAREN H. STUMP, Teaching Professor and Director of Undergraduate Studies and Laboratories – M.S., Carnegie Mellon University; Carnegie Mellon, 1983–.
RYAN SULLIVAN, Assistant Professor of Chemistry and Mechanical Engineering – Ph.D., University of California, San Diego; Carnegie Mellon, 2012–.
LEONARD VUCOLO, Assistant Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006–.
GARRY F. P. WARNOCK, Associate Teaching Professor – Ph.D., University of Minnesota; Carnegie Mellon, 1997–.
NEWELL WASHBURN, Associate Professor of Chemistry and Biomedical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–.
DAVID YARON, Associate Professor of Chemistry – Ph.D., Harvard University; Carnegie Mellon, 1992–.

Emeriti
GUY C. BERRY, University Professor of Chemistry and Polymer Science, Emeritus – Ph.D., University of Michigan; Carnegie Mellon, 1960–.
AKSEL A. BOTHNER-BY, Professor of Chemistry, Emeritus – Ph.D., Harvard University; Carnegie Mellon, 1956–.
ALBERT A. CARETTO JR., Professor of Chemistry, Emeritus – Ph.D., University of Rochester; Carnegie Mellon, 1959–.
JOSEF DADOK, Professor of Chemical Instrumentation, Emeritus – Ph.D., Czechoslovak Academy of Sciences; Carnegie Mellon, 1967–.
MORTON KAPLAN, Professor of Chemistry, Emeritus – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970–.
PAUL J. KAROL, Professor of Chemistry, Emeritus – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1969–.
ROBERT L. KAY, Professor of Chemistry, Emeritus – Ph.D., University of Toronto; Carnegie Mellon, 1963–.
STUART W. STALEY, Professor of Chemistry, Emeritus – Ph.D., Yale University; Carnegie Mellon, 1986–.

ROBERT F. STEWART, Professor of Chemistry, Emeritus – Ph.D., California Institute of Technology; Carnegie Mellon, 1978–.

CHARLES H. VAN DYKE, Associate Professor of Chemistry, Emeritus – Ph.D., University of Pennsylvania; Carnegie Mellon, 1963–.

Courtesy

MICHAEL BOCKSTALLER, Associate Professor of Materials Science Engineering and Faculty of Chemistry – Ph.D., Johannes Gutenberg University (Germany); Carnegie Mellon, 2005–.

ALEX EVILEVITCH, Associate Professor of Physics and Faculty of Chemistry – Ph.D., Lund University; Carnegie Mellon, 2009–.

ANDREW GELLMAN, Thomas Lord Professor of Chemical Engineering and Head, Department of Chemical Engineering and Professor of Materials Science Engineering and Chemistry – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992–.

GORDON RULE, Professor of Biological Sciences and Faculty of Biomedical Engineering and Chemistry – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995–.

JAMES SCHNEIDER, Professor of Chemical Engineering and Faculty of Biomedical Engineering and Chemistry – Ph.D., University of Minnesota; Carnegie Mellon, 1999–.

ALAN S. WAGGONER, Professor of Biological Sciences, Director, Molecular Biosensor and Imaging Center and Faculty of Biomedical Engineering and Chemistry – Ph.D., University of Oregon; Carnegie Mellon, 1982–.

LYNN WALKER, Professor of Chemical Engineering and Faculty of Chemistry – Ph.D., University of Delaware; Carnegie Mellon, 1997–.

Adjunct Faculty

COLIN HORWITZ, Adjunct Research Professor of Chemistry and Chief Technology Officer, GreenOx Catalysts – Ph.D., Northwestern University; Carnegie Mellon, 1993–.

JOHN PETERSON MYERS, CEO and Chief Scientist of Environmental Health Services – Ph.D., University of California at Berkeley; .

JAMES PETERSON, Associate Professor, Department of Environmental and Occupational Health, University of Pittsburgh – Ph.D., University of Essex (United Kingdom); .
Department of Mathematical Sciences

Thomas Bohman, Department Head
William J. Hrusa, Associate Head
John F. Mackey, Associate Head
Office: Wean Hall 6113
http://www.math.cmu.edu

Mathematics provides much of the language and quantitative underpinnings of the natural and social sciences, and mathematical scientists have been responsible for the development of many of the most commonly used tools in business management as well as for laying the foundation for computational and computer science. The name of the Department of Mathematical Sciences reflects its tradition of outstanding research and teaching of applicable mathematics relating to these areas. Indeed, the Department contains highly ranked research groups in Applied Mathematics, Discrete Mathematics, Logic, and Mathematical Finance. These research strengths are reflected in the variety of options that the Department provides for its undergraduate majors.


The B.S. in Mathematics Curriculum is the least structured of our programs, in recognition of the wide variety of interests that can be productively coupled with the study of mathematical sciences. It can be an appropriate choice for students planning for graduate study in mathematics or seeking to design their curriculum to take advantage of the many opportunities for a second major from another department in the University.

The Operations Research and Statistics Concentration prepares students to enter the area of operations research, which is expected to be among the growth occupations over the next decade. Mathematicians with a background in operations research are especially valuable in such diverse activities as project planning, production scheduling, market forecasting and finance. Such applications are found in virtually all industrial and governmental settings.

The Statistics Concentration prepares students to contribute to a wide variety of research areas. Applications range from experimental design and data analysis in the physical and social sciences, medicine and engineering, to modeling and forecasting in business and government, to actuarial applications in the financial and insurance industries. This is also a useful second major for students planning for graduate study and research in subject areas requiring a strong statistical background.

The Discrete Mathematics and Logic Concentration provides a background in discrete mathematics, mathematical logic, and theoretical computer science. This concentration prepares the student to do research in these and related fields, or to apply their ideas elsewhere.

Finally, the Computational and Applied Mathematics Concentration provides the background needed to support the computational and mathematical analysis needs of a wide variety of businesses and industries and is well suited to students with an interest in the physical sciences and engineering.

The Department places great emphasis on the advising of students. This is critical if students are to make the most of their years at the University. Students are urged to work carefully with their advisor and other faculty to formulate their degree programs. Study abroad is encouraged, and an interested student should investigate the opportunities available in the Undergraduate Options section of the catalog.

Special options within the Department

The Department offers special opportunities for the exceptionally well-prepared and intellectually ambitious student. These options are available to students from any department in the University.

Matrix Theory and Vector Analysis

For selected Freshmen entering the University, we offer the Fall/Spring sequence of 21-242 Matrix Theory and 21-269 Vector Analysis, which include a rigorous introduction to proofs and abstract mathematics. Typically, a student choosing this sequence has mastered the operational aspects of high school mathematics and now seeks a deeper conceptual understanding.

Mathematical Studies

Following the 21-242/21-269 sequence, we offer Mathematical Studies Analysis I/II and Mathematical Studies Algebra I/II. These courses provide excellent preparation for graduate study, with many of the participants taking graduate courses as early as their Junior year. The typical enrollment of about 15 students allows for close contact with faculty. Admission to Mathematical Studies is by invitation, and interested students should apply during the Spring of their Freshman year.

Honors Degree Program

This demanding program qualifies the student for two degrees: The Bachelor of Science and the Master of Science in Mathematical Sciences. This program typically includes the Mathematical Studies option. For students who complete the Mathematical Studies sequence, the Master of Science degree in Mathematical Sciences may be earned together with a Bachelor of Science from another department.

Interdisciplinary Programs

Several interdisciplinary options enable a student to combine mathematics with other disciplines.

- The Bachelor of Science and Arts (p. 78) program allows a student to combine mathematics with study in any of the five schools in the College of Fine Arts.
- The Science and Humanities Scholars (p. 68) program includes an option shared with the Statistics Department in the Humanities and Social Sciences College that leads to a BS in Mathematics and Statistics.
- The Bachelor of Science in Mathematics and Economics (p. 313) is a flexible program which allows students to develop depth in both fields of study. Note: for students whose home college is Dietrich College, this major is known as the Bachelor of Science in Economics and Mathematical Sciences.
- Finally, a joint program with the Heinz College of Public Policy and Management and the Tepper School of Business leads to the degree Bachelor of Science in Computational Finance (http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/#bachelorofsciencecomputationalfinance).

Curricula

For each concentration, we provide a list of the requirements and a suggested schedule that takes prerequisites into account. A Mathematical Sciences, Statistics, or Computer Science Elective refers to a course from any of the Departments of Mathematical Sciences, Statistics or Computer Science. The only restrictions on these electives are that a mathematical sciences course must be at the 21-300 level or above 21-270 or 21-292, a statistics course must have at least 36-225 as a prerequisite, and a computer science course must be at the 15-200 level or above.

Mathematical Sciences majors are required to complete an introductory computer science course, either 15-110 or 15-112. Students who plan to take further computer science courses must complete 15-112.

An H&SS Elective refers to a course in the Dietrich College of Humanities and Social Sciences requirements as described in the catalog section for the Mellon College of Science. A course listed as an Elective is a free elective with the only restriction that the maximum total of ROTC, STUCO, and Physical Education units that will be accepted for graduation is nine.

For a list of courses required for all MCS students see “First Year for Science Students.” (p. 255)

In addition to the courses in the suggested schedules below, a student majoring in mathematical sciences also takes the one unit course 21-201 Undergraduate Colloquium each semester of the Sophomore year. This course plays an important role in introducing students to career opportunities, graduate school preparation, and student and faculty research in the Department.

Mathematics Degree

This program is the most flexible available to our majors. The flexibility to choose eight electives within the major plus seven humanities courses and seven free electives allows the student to design a program to suit his or her individual needs and interests. The requirements for the Mathematics Degree are:
Mathematical Sciences Courses (required)
The alternative courses 21-242, 21-261, and 21-268 (or 21-269) are particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus 10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation 10</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics 10</td>
</tr>
<tr>
<td>21-201</td>
<td>Undergraduate Colloquium 1</td>
</tr>
<tr>
<td>(Taken twice in Sophomore year.)</td>
<td></td>
</tr>
<tr>
<td>21-228</td>
<td>Discrete Mathematics 9-12</td>
</tr>
<tr>
<td>or 21-251</td>
<td>Great Theoretical Ideas in Computer Science</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations 10</td>
</tr>
<tr>
<td>or 21-242</td>
<td>Matrix Theory</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory 9</td>
</tr>
<tr>
<td>or 21-325</td>
<td>Probability</td>
</tr>
<tr>
<td>21-359</td>
<td>Calculus in Three Dimensions 9-10</td>
</tr>
<tr>
<td>or 21-268</td>
<td>Multidimensional Calculus</td>
</tr>
<tr>
<td>or 21-269</td>
<td>Vector Analysis</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations 9-10</td>
</tr>
<tr>
<td>or 21-261</td>
<td>Introduction to Ordinary Differential Equations</td>
</tr>
<tr>
<td>21-341</td>
<td>Linear Algebra 9</td>
</tr>
<tr>
<td>21-355</td>
<td>Principles of Real Analysis I 9</td>
</tr>
<tr>
<td>21-356</td>
<td>Principles of Real Analysis II 9</td>
</tr>
<tr>
<td>21-373</td>
<td>Algebraic Structures 9</td>
</tr>
</tbody>
</table>

413-118

Forty-five units of (required) Mathematical Sciences electives (at the 21-300 level or above or 21-270 or 21-292).

Three (required) Mathematical Sciences (at the 21-300 level or above or 21-270 or 21-292), or Statistics (must have at least 36-225 as a prerequisite), or Computer Science (at the 15-200 level or above) electives.

MCS General Education (required)
MCS or SHS humanities, social sciences, and science core (114 units)

Mathematical Sciences Electives for Students Intending Graduate Studies
Students preparing for graduate study in mathematics should consider the following courses as Mathematical Sciences electives, choosing among them according to the desired area of graduate study:

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-301</td>
<td>Combinatorics 9</td>
</tr>
<tr>
<td>21-371</td>
<td>Functions of a Complex Variable 9</td>
</tr>
<tr>
<td>21-372</td>
<td>Partial Differential Equations 9</td>
</tr>
<tr>
<td>21-374</td>
<td>Field Theory 9</td>
</tr>
<tr>
<td>21-441</td>
<td>Number Theory 9</td>
</tr>
<tr>
<td>21-465</td>
<td>Topology 9</td>
</tr>
<tr>
<td>21-467</td>
<td>Differential Geometry 9</td>
</tr>
<tr>
<td>21-470</td>
<td>Selected Topics in Analysis 9</td>
</tr>
<tr>
<td>21-476</td>
<td>Ordinary Differential Equations 9</td>
</tr>
<tr>
<td>21-484</td>
<td>Graph Theory 9</td>
</tr>
<tr>
<td>21-400</td>
<td>Mathematical Logic I 12</td>
</tr>
<tr>
<td>21-402</td>
<td>Introduction to Set Theory I 12</td>
</tr>
<tr>
<td>21-403</td>
<td>Model Theory I 12</td>
</tr>
<tr>
<td>21-410</td>
<td>Algebra I 12</td>
</tr>
<tr>
<td>21-420</td>
<td>Real Analysis 6</td>
</tr>
<tr>
<td>21-621</td>
<td>Introduction to Lebesgue Integration 6</td>
</tr>
<tr>
<td>21-630</td>
<td>Ordinary Differential Equations 12</td>
</tr>
<tr>
<td>21-640</td>
<td>Introduction to Functional Analysis 12</td>
</tr>
<tr>
<td>21-651</td>
<td>General Topology 12</td>
</tr>
<tr>
<td>21-660</td>
<td>Introduction to Numerical Analysis I 12</td>
</tr>
<tr>
<td>21-701</td>
<td>Discrete Mathematics 12</td>
</tr>
<tr>
<td>21-720</td>
<td>Measure and Integration 12</td>
</tr>
<tr>
<td>21-721</td>
<td>Probability 12</td>
</tr>
<tr>
<td>21-737</td>
<td>Probabilistic Combinatorics 12</td>
</tr>
<tr>
<td>21-738</td>
<td>Extremal Combinatorics 12</td>
</tr>
</tbody>
</table>

Note that courses 21-600 and above carry graduate credit. Courses at the 600 level are designed as transitional courses to graduate study. A student preparing for graduate study should also consider undertaking independent work. The Department offers 21-499 Undergraduate Research Topic and 21-599 Undergraduate Reading and Research for this purpose.

Courses 21-700 and above can be used with the permission of both the instructor and the department.

Suggested Schedule

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus 10</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics 10</td>
</tr>
<tr>
<td>33-111</td>
<td>Physics I for Science Students 12</td>
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Spring

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<th>Units</th>
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<tbody>
<tr>
<td>76-101</td>
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<td>99-101</td>
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Sophomore Year

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<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>01-121</td>
<td>Modern Biology 9</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I 10</td>
</tr>
<tr>
<td>21-201</td>
<td>Undergraduate Colloquium 1</td>
</tr>
<tr>
<td>21-228</td>
<td>Discrete Mathematics 9-12</td>
</tr>
<tr>
<td>or 35-251</td>
<td>Great Theoretical Ideas in Computer Science</td>
</tr>
<tr>
<td>21-268</td>
<td>Multidimensional Calculus 10</td>
</tr>
<tr>
<td>21-269</td>
<td>Vector Analysis</td>
</tr>
</tbody>
</table>

| xx-xxx | H&SS Elective 9 |

Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-355</td>
<td>Principles of Real Analysis I 9</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory 9</td>
</tr>
<tr>
<td>or 21-325</td>
<td>Probability</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Mathematical Sci, Statistics, or Computer Sci Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective 9</td>
</tr>
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</table>

Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective 9</td>
</tr>
</tbody>
</table>

| xx-xxx | Free Elective 9 |

Minimum number of units for the degree: 360

Operations Research and Statistics Concentration
An operations research professional employs quantitative and computational skills toward enhancing the function of an organization or process. Students choosing this concentration will develop problem-solving abilities in mathematical and statistical modeling and computer-based simulation in areas such as network design, transportation scheduling, allocation of resources and optimization. In addition to courses in mathematics and statistics, a basic background in economics and accounting is included. Since problems in business and industry are often solved by teams, the program also includes a group project to be undertaken in the Senior year. Students choosing this concentration may

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
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<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Mathematical Sci, Statistics, or Computer Sci Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective 9</td>
</tr>
</tbody>
</table>

| xx-xxx | Free Elective 9 |

| April-5 | 45 |

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective 9</td>
</tr>
</tbody>
</table>

| xx-xxx | Free Elective 9 |

| April-5 | 45 |

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
</tr>
<tr>
<td>21-xxx</td>
<td>Mathematical Sciences Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Mathematical Sci, Statistics, or Computer Sci Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS Elective 9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective 9</td>
</tr>
</tbody>
</table>

| xx-xxx | Free Elective 9 |

| April-5 | 45 |
not pursue an additional major or minor in Statistics in the Humanities and Social Sciences College.

The requirements for the concentration in Operations Research and Statistics are:

### Mathematical Sciences Courses (required)

The alternative courses 21-242, 21-261, and 21-268 (or 21-269) are particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-201 Undergraduate Colloquium (Taken twice in Sophomore year)</td>
<td>1</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9-12</td>
</tr>
<tr>
<td>15-251 Great Theoretical Ideas in Computer Science</td>
<td></td>
</tr>
<tr>
<td>or 21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
<td></td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9-10</td>
</tr>
<tr>
<td>or 21-268 Multidimensional Calculus</td>
<td></td>
</tr>
<tr>
<td>or 21-269 Vector Analysis</td>
<td></td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9-10</td>
</tr>
<tr>
<td>or 21-261 Introduction to Ordinary Differential Equations</td>
<td></td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
<td>9</td>
</tr>
<tr>
<td>21-369 Numerical Methods</td>
<td>9</td>
</tr>
<tr>
<td>21-393 Operations Research II</td>
<td>9</td>
</tr>
<tr>
<td>21-484 Projects in Applied Mathematics</td>
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</tr>
<tr>
<td>21-490 Topics in Applied Mathematics</td>
<td></td>
</tr>
<tr>
<td>21-370 Discrete Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>21-371 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Continuous-Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>21-484 Graph Theory</td>
<td>9</td>
</tr>
<tr>
<td>36-462 Special Topics: Epidemiology</td>
<td>9</td>
</tr>
<tr>
<td>36-462 Topics in Statistics:</td>
<td></td>
</tr>
<tr>
<td>36-463 Multilevel and Hierarchical Models</td>
<td></td>
</tr>
<tr>
<td>36-464 Topics in Statistics: Applied Multivariate Methods</td>
<td></td>
</tr>
<tr>
<td>70-271 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-460 Mathematical Models for Consulting</td>
<td></td>
</tr>
<tr>
<td>70-471 Logistics and Supply Chain Management</td>
<td></td>
</tr>
</tbody>
</table>

### Statistics Courses (required)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>or 21-325 Probability</td>
<td></td>
</tr>
<tr>
<td>36-226 Introduction to Statistical Inference</td>
<td></td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td>9</td>
</tr>
<tr>
<td>36-402 Advanced Data Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-410 Introduction to Probability Modeling</td>
<td>9</td>
</tr>
</tbody>
</table>

### Economics, Business, and Computer Science Courses (required)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110 Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>73-310 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
</tbody>
</table>

### Depth Electives (required)

Five depth electives (required), to be chosen from the list below. The course 21-355 is particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>15-150 Principles of Functional Programming</td>
<td>10</td>
</tr>
<tr>
<td>15-210 Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>21-270 Introduction to Mathematical Finance</td>
<td>9</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>9</td>
</tr>
<tr>
<td>21-341 Linear Algebra</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-356 Principles of Real Analysis II</td>
<td>9</td>
</tr>
<tr>
<td>21-365 Projects in Applied Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-366 Topics in Applied Mathematics</td>
<td>9</td>
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<tr>
<td>21-370 Discrete Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-420 Continuous-Time Finance</td>
<td>9</td>
</tr>
<tr>
<td>21-484 Graph Theory</td>
<td>9</td>
</tr>
<tr>
<td>36-462 Special Topics: Epidemiology</td>
<td>9</td>
</tr>
<tr>
<td>36-462 Topics in Statistics:</td>
<td></td>
</tr>
<tr>
<td>36-463 Multilevel and Hierarchical Models</td>
<td></td>
</tr>
<tr>
<td>36-464 Topics in Statistics: Applied Multivariate Methods</td>
<td></td>
</tr>
<tr>
<td>70-271 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-460 Mathematical Models for Consulting</td>
<td></td>
</tr>
<tr>
<td>70-471 Logistics and Supply Chain Management</td>
<td></td>
</tr>
</tbody>
</table>

### MCS General Education (required)

MCS or SHS humanities, social sciences, and science core (114 units) Note that 73-100, 73-230, and 73-240 satisfy requirements from the MCS general education core.

### Suggested Schedule

#### Freshman Year

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

#### Spring Units

<table>
<thead>
<tr>
<th>Spring Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110 Principles of Computing</td>
</tr>
<tr>
<td>21-325 Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
</tr>
<tr>
<td>21-242 Matrix Theory</td>
</tr>
<tr>
<td>33-112 Physics II for Science Students</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
<tr>
<td>Total</td>
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</table>

#### Sophomore Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>21-201 Undergraduate Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9-12</td>
</tr>
<tr>
<td>15-251 Great Theoretical Ideas in Computer Science</td>
<td></td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9-10</td>
</tr>
<tr>
<td>or 21-268 Multidimensional Calculus</td>
<td></td>
</tr>
<tr>
<td>or 21-269 Vector Analysis</td>
<td></td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
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<tr>
<td>Total</td>
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#### Spring Units

<table>
<thead>
<tr>
<th>Spring Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-260 Differential Equations</td>
</tr>
<tr>
<td>or 21-261 Introduction to Ordinary Differential Equations</td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
</tr>
<tr>
<td>21-201 Undergraduate Colloquium</td>
</tr>
<tr>
<td>70-122 Introduction to Accounting</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
<tr>
<td>xx-xxx Free Elective</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

#### Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-369 Numerical Methods</td>
<td>9</td>
</tr>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>or 21-325 Probability</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
<td>9</td>
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<tr>
<td>xx-xxx Free Elective</td>
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</tr>
<tr>
<td>Total</td>
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#### Spring Units

<table>
<thead>
<tr>
<th>Spring Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-226 Introduction to Statistical Inference</td>
</tr>
<tr>
<td>36-410 Introduction to Probability Modeling</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

#### Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-393 Operations Research II</td>
<td>9</td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Free Elective</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
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</table>

#### Spring Units

<table>
<thead>
<tr>
<th>Spring Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-402 Advanced Data Analysis</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx Free Elective</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

### Statistics Concentration

Statistics is concerned with the process by which inferences are made from data. Statistical methods are essential to research in a wide variety of
scientific disciplines. For example, principles of experimental design that assist chemists in improving their yields also help poultry farmers grow bigger chickens. Similarly, time series analysis is used to better understand radio waves from distant galaxies, hormone levels in the blood, and concentrations of pollutants in the atmosphere. This diversity of application is an exciting aspect of the field, and it is one reason for the current demand for well-trained statisticians.

The courses 36-225 Introduction to Probability Theory and 36-226 Introduction to Statistical Inference taken in the Junior year serve as the basis for all further statistics courses. The course 21-325 is a more mathematical alternative to 36-225.

The Statistics Concentration is jointly administered by the Department of Mathematical Sciences and the Department of Statistics. The Department of Statistics considers applications for the master’s program from undergraduates in the junior year. Students who are accepted are expected to finish their undergraduate studies, using some electives in the Senior year to take courses recommended by the Department of Statistics. This will ensure a strong background to permit completion of the master’s program in one year beyond the baccalaureate. The requirements for the Statistics Concentration are:

Mathematical Sciences Courses (required)

The alternative courses 21-242, 21-261, and 21-268 (or 21-269) are particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
</tr>
<tr>
<td>21-201</td>
<td>Undergraduate Colloquium</td>
</tr>
<tr>
<td>21-228</td>
<td>Great Theoretical Ideas in Computer Science</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
</tr>
<tr>
<td>21-242</td>
<td>Matrix Theory</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>21-268</td>
<td>Multidimensional Calculus</td>
</tr>
<tr>
<td>21-269</td>
<td>Vector Analysis</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>or 21-261</td>
<td>Introduction to Ordinary Differential Equations</td>
</tr>
<tr>
<td>21-292</td>
<td>Operations Research I</td>
</tr>
<tr>
<td>21-369</td>
<td>Numerical Methods</td>
</tr>
<tr>
<td>21-393</td>
<td>Operations Research II</td>
</tr>
</tbody>
</table>

Statistics Courses (required)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
</tr>
<tr>
<td>or 21-325</td>
<td>Probability</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
</tr>
<tr>
<td>36-402</td>
<td>Advanced Data Analysis</td>
</tr>
<tr>
<td>36-410</td>
<td>Introduction to Probability Modeling</td>
</tr>
</tbody>
</table>

Economics and Computer Science Courses (required)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
</tr>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
</tbody>
</table>

Depth Electives (required)

Four depth electives, including at least one statistics course, to be chosen from the list below. The course 21-355 Principles of Real Analysis I is particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-150</td>
<td>Principles of Functional Programming</td>
</tr>
<tr>
<td>15-210</td>
<td>Parallel and Sequential Data Structures and Algorithms</td>
</tr>
<tr>
<td>21-270</td>
<td>Introduction to Mathematical Finance</td>
</tr>
<tr>
<td>21-341</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>21-355</td>
<td>Principles of Real Analysis I</td>
</tr>
<tr>
<td>21-356</td>
<td>Principles of Real Analysis II</td>
</tr>
<tr>
<td>21-365</td>
<td>Projects in Applied Mathematics</td>
</tr>
<tr>
<td>21-366</td>
<td>Topics in Applied Mathematics</td>
</tr>
<tr>
<td>21-370</td>
<td>Discrete Time Finance</td>
</tr>
<tr>
<td>21-373</td>
<td>Algebraic Structures</td>
</tr>
<tr>
<td>21-420</td>
<td>Continuous-Time Finance</td>
</tr>
<tr>
<td>21-484</td>
<td>Graph Theory</td>
</tr>
<tr>
<td>36-461</td>
<td>Special Topics: Epidemiology</td>
</tr>
<tr>
<td>36-462</td>
<td>Topics in Statistics</td>
</tr>
<tr>
<td>36-463</td>
<td>Multilevel and Hierarchical Models</td>
</tr>
<tr>
<td>36-464</td>
<td>Topics in Statistics: Applied Multivariate Methods</td>
</tr>
</tbody>
</table>

MCS General Education (required)

MCS or H&SS humanities, social sciences, and science core (114 units)

Note that 73-100 satisfies the requirement from the MCS core.

Suggested Schedule

**Freshman Year**

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Modern Biology</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
</tr>
</tbody>
</table>

**Spring Units**

<table>
<thead>
<tr>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112 Fundamentals of Programming and Computer Science</td>
</tr>
<tr>
<td>21-212 Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
</tr>
<tr>
<td>or 21-269 Vector Analysis</td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
</tr>
</tbody>
</table>

**Sophomore Year**

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-105 Introduction to Modern Chemistry</td>
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<tr>
<td>21-201 Undergraduate Colloquium</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
</tr>
<tr>
<td>or 15-251 Great Theoretical Ideas in Computer Science</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
</tr>
<tr>
<td>or 21-268 Multidimensional Calculus</td>
</tr>
<tr>
<td>21-269 Vector Analysis</td>
</tr>
<tr>
<td>15-122 Principles of Imperative Computation</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
</tr>
<tr>
<td>or 21-261 Introduction to Ordinary Differential Equations</td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
</tr>
<tr>
<td>21-369 Numerical Methods</td>
</tr>
<tr>
<td>21-393 Operations Research II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112 Principles of Imperative Computation</td>
</tr>
<tr>
<td>36-401 Introduction to Probabilistic Programming</td>
</tr>
<tr>
<td>36-410 Introduction to Probability Modeling</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
</tr>
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</table>

**Junior Year**

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-369 Numerical Methods</td>
</tr>
<tr>
<td>36-225 Introduction to Probability Theory</td>
</tr>
<tr>
<td>or 21-325 Probability</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics</td>
</tr>
</tbody>
</table>

**Senior Year**

<table>
<thead>
<tr>
<th>Fall Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-393 Operations Research I</td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
<tr>
<td>xx-xxx Free Elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-402 Advanced Data Analysis</td>
</tr>
<tr>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Elective</td>
</tr>
<tr>
<td>xx-xxx Free Elective</td>
</tr>
</tbody>
</table>
Minimum number of units required for the degree: 360

Discrete Mathematics and Logic Concentration

Discrete mathematics is the study of finite and countable structures and algorithms for the manipulation and analysis of such structures, while mathematical logic is the study of axiomatic systems and their mathematical applications. Both are flourishing research areas and have close ties with computer science.

The Discrete Mathematics and Logic Concentration provides a firm background in discrete mathematics and mathematical logic, together with the elements of theoretical computer science. It prepares the student to pursue research in these fields, or to apply their ideas in the many disciplines (ranging from philosophy to hardware verification) where such ideas have proved relevant.

The requirements for the Discrete Mathematics and Logic Concentration are:

Mathematical Sciences and Computer Science Courses (required)

The alternative course 21-242 is particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>15-150 Principles of Functional Programming</td>
<td>10</td>
</tr>
<tr>
<td>15-210 Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-201 Undergraduate Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>(Taken twice in Sophomore year.)</td>
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</tr>
<tr>
<td>21-300 Basic Logic</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
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</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
<td>10</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9-12</td>
</tr>
<tr>
<td>or 15-251 Great Theoretical Ideas in Computer Science</td>
<td></td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>9</td>
</tr>
<tr>
<td>21-341 Linear Algebra</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-451 Algorithm Design and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>15-453 Formal Languages, Automata, and Computability</td>
<td>9</td>
</tr>
<tr>
<td>15-451 Algorithm Design and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>9</td>
</tr>
<tr>
<td>21-341 Linear Algebra</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
</tbody>
</table>

127-130

Computer Science electives (required)

Any two courses at the 300 level or above. The following are specifically suggested:

- 15-312 Foundations of Programming Languages: 12 units
- 15-451 Algorithm Design and Analysis: 12 units
- 15-453 Formal Languages, Automata, and Computability: 9 units

Students pursuing this concentration who minor in Computer Science must take two additional Computer Science courses at the 300 level or above to avoid excessive double counting.

Mathematical Sciences Electives (required)

Seven courses from lists 1 and 2 below, including at least three chosen from list 1.

List 1 (Discrete Mathematics and Logic Electives)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-325 Probability</td>
<td>9</td>
</tr>
<tr>
<td>21-329 Set Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-374 Field Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-441 Number Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-484 Graph Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-602 Introduction to Set Theory</td>
<td>12</td>
</tr>
<tr>
<td>21-603 Model Theory I</td>
<td>12</td>
</tr>
<tr>
<td>21-610 Algebra I</td>
<td>12</td>
</tr>
<tr>
<td>21-700 Mathematical Logic II</td>
<td>12</td>
</tr>
<tr>
<td>80-405 Game Theory</td>
<td>9</td>
</tr>
<tr>
<td>80-411 Proof Theory</td>
<td>9</td>
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<tr>
<td>80-413 Category Theory</td>
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</table>

List 2 (General Mathematics Electives)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-250 Calculus in Three Dimensions</td>
<td>9-10</td>
</tr>
<tr>
<td>or 21-268 Multidimensional Calculus</td>
<td></td>
</tr>
<tr>
<td>or 21-269 Vector Analysis</td>
<td></td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9-10</td>
</tr>
<tr>
<td>or 21-261 Introduction to Ordinary Differential Equations</td>
<td></td>
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<tr>
<td>21-292 Operations Research I</td>
<td>9</td>
</tr>
<tr>
<td>21-356 Principles of Real Analysis II</td>
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</tr>
<tr>
<td>21-371 Functions of a Complex Variable</td>
<td>9</td>
</tr>
<tr>
<td>21-372 Partial Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>21-393 Operations Research II</td>
<td>9</td>
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</tbody>
</table>

List 2 (General Mathematics Electives)

21-465 Topology                           | 9     |
21-467 Differential Geometry              | 9     |
21-476 Ordinary Differential Equations    | 9     |

MCS General Education (required)

MCS or SHS humanities, social sciences, and science core (114 units)

Suggested Schedule

Freshman Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
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</tr>
<tr>
<td>15-112 Fundamentals of Programming and Computer Science</td>
<td>12</td>
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<tr>
<td>21-120 Differential and Integral Calculus</td>
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<tr>
<td>33-111 Physics I for Science Students</td>
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<tr>
<td>76-101 Interpretation and Argument</td>
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<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td>3</td>
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<tr>
<td>21-201 Undergraduate Colloquium</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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</tr>
<tr>
<td>21-374 Field Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
<td></td>
</tr>
<tr>
<td>Senior Year</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>15-112 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
<td></td>
</tr>
<tr>
<td>21-201 Undergraduate Colloquium</td>
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</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-374 Field Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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<td>10</td>
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<tr>
<td>or 21-242 Matrix Theory</td>
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<tr>
<td>Sophomore Year</td>
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<tr>
<td>Fall</td>
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</tr>
<tr>
<td>15-110 Principles of Functional Programming</td>
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<tr>
<td>21-268 Multidimensional Calculus</td>
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<tr>
<td>or 21-269 Vector Analysis</td>
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</tr>
<tr>
<td>21-301 Combinatorics</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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<td>21-374 Field Theory</td>
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<td>21-355 Principles of Real Analysis I</td>
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<td>21-373 Algebraic Structures</td>
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<tr>
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<td>10</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
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<tr>
<td>Senior Year</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
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<tr>
<td>15-112 Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
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<tr>
<td>21-241 Matrices and Linear Transformations</td>
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<tr>
<td>or 21-242 Matrix Theory</td>
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<td>Junior Year</td>
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<tr>
<td>Fall</td>
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<tr>
<td>15-xxx Computer Science Elective</td>
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<tr>
<td>21-300 Basic Logic</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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</tr>
<tr>
<td>21-374 Field Theory</td>
<td>9</td>
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<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
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</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
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</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
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<tr>
<td>Senior Year</td>
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<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>15-xxx Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>21-300 Basic Logic</td>
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<tr>
<td>21-355 Principles of Real Analysis I</td>
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<td>21-355 Principles of Real Analysis I</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
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<tr>
<td>Senior Year</td>
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</tr>
<tr>
<td>Spring</td>
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<tr>
<td>15-xxx Computer Science Elective</td>
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<tr>
<td>21-300 Basic Logic</td>
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<tr>
<td>21-355 Principles of Real Analysis I</td>
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<tr>
<td>21-373 Algebraic Structures</td>
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</tr>
<tr>
<td>21-374 Field Theory</td>
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</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
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<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>or 21-242 Matrix Theory</td>
<td></td>
</tr>
</tbody>
</table>
**Computational and Applied Mathematics Concentration**

This concentration is designed to prepare students for careers in business or industry which require significant analytical, computational and problem solving skills. It also prepares students with interest in computational and applied mathematics for graduate school.

The students in this concentration develop skills to choose the right framework to quantify or model a problem, analyze it, simulate and in general use appropriate techniques for carrying the effort through to an effective solution. The free electives allow the student to develop an interest in a related area by completing a minor in another department such as Engineering Studies, Economics, Information Systems or Business Administration.

The requirements for the Computational and Applied Mathematics Concentration are:

### Mathematical Sciences Courses (required)

The alternative courses 21-242, 21-261, and 21-268 (or 21-269) are particularly recommended for a student planning to pursue graduate work.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations</td>
<td>10</td>
</tr>
<tr>
<td>21-123</td>
<td>Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-201</td>
<td>Undergraduate Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>21-228</td>
<td>Discrete Mathematics</td>
<td>9-12</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
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</tr>
<tr>
<td>21-268</td>
<td>Multidimensional Calculus</td>
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</tr>
<tr>
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<td>Vector Analysis</td>
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<tr>
<td>21-260</td>
<td>Differential Equations</td>
<td>9-10</td>
</tr>
<tr>
<td>21-320</td>
<td>Introduction to Ordinary Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>21-325</td>
<td>Probability</td>
<td>9</td>
</tr>
<tr>
<td>21-355</td>
<td>Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-356</td>
<td>Principles of Real Analysis II</td>
<td>9</td>
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<tr>
<td>21-369</td>
<td>Numerical Methods</td>
<td>9</td>
</tr>
<tr>
<td>21-356</td>
<td>Principles of Real Analysis II</td>
<td>9</td>
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</table>

**Computer Science Courses (required)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
<td>10</td>
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</table>

### Depth Electives (required)

Students must take 45 units from the list below:

- 21-292 Operations Research I 9
- 21-365 Projects in Applied Mathematics 9
- 21-366 Topics in Applied Mathematics 9
- 21-370 Discrete Time Finance 9
- 21-371 Functions of a Complex Variable 9
- 21-372 Partial Differential Equations 9
- 21-393 Operations Research II 9
- 21-400 Continuous-Time Finance 9
- 21-401 Differential Geometry 9
- 21-407 Selected Topics in Analysis 9
- 21-476 Ordinary Differential Equations 9
- 21-499 Undergraduate Research Topic 9
- 21-599 Undergraduate Reading and Research 9
- 21-620 Real Analysis 6
- 21-621 Introduction to Labesque Integration 6
- 21-630 Ordinary Differential Equations 12
- 21-640 Introduction to Functional Analysis 12
- 21-645 General Topology 12
- 21-660 Introduction to Numerical Analysis I 12
- 21-690 Methods of Optimization 12
- 21-710 Measure and Integration 12
- 21-721 Probability 12
- 21-732 Partial Differential Equations I 12
- 36-410 Introduction to Probability Modeling 9

21-366 Topics in Applied Mathematics and 21-470 Selected Topics in Analysis have content that varies from year to year. These courses can be taken more than once (with permission).

### Suggested Schedule

#### Freshman Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>09-101 Introduction to Experimental Chemistry 3</td>
</tr>
<tr>
<td></td>
<td>21-120 Differential and Integral Calculus 10</td>
</tr>
<tr>
<td></td>
<td>21-126 Introduction to Mathematical Software 3</td>
</tr>
<tr>
<td></td>
<td>21-127 Concepts of Mathematics 10</td>
</tr>
<tr>
<td></td>
<td>33-111 Physics I for Science Students 12</td>
</tr>
<tr>
<td></td>
<td>76-101 Interpretation and Argument 9</td>
</tr>
<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21-228 Discrete Mathematics 9</td>
</tr>
<tr>
<td></td>
<td>21-241 Matrices and Linear Transformations 10</td>
</tr>
<tr>
<td></td>
<td>33-112 Physics II for Science Students 12</td>
</tr>
<tr>
<td></td>
<td>xx-xxx H&amp;SS Elective 9</td>
</tr>
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</table>

#### Sophomore Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>09-105 Introduction to Modern Chemistry I 10</td>
</tr>
<tr>
<td></td>
<td>15-112 Fundamentals of Programming and Computer Science 12</td>
</tr>
<tr>
<td></td>
<td>21-268 Multidimensional Calculus 10</td>
</tr>
<tr>
<td></td>
<td>21-269 Vector Analysis 9</td>
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<tr>
<td></td>
<td>21-201 Undergraduate Colloquium 1</td>
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<tr>
<td></td>
<td>xx-xxx H&amp;SS Elective 9</td>
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<tr>
<td></td>
<td>xx-xxx Free Elective 9</td>
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<tr>
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<td></td>
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<tr>
<td></td>
<td>03-121 Modern Biology 9</td>
</tr>
<tr>
<td></td>
<td>33-111 Physics I for Science Students 12</td>
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<td>xx-xxx H&amp;SS Elective 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Free Elective 9</td>
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</table>

#### Junior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
<td>21-320 Symbolic Programming Methods 9</td>
</tr>
<tr>
<td></td>
<td>21-325 Probability 9</td>
</tr>
<tr>
<td></td>
<td>21-355 Principles of Real Analysis I 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx H&amp;SS Elective 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Free Elective 9</td>
</tr>
<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21-356 Principles of Real Analysis II 9</td>
</tr>
<tr>
<td></td>
<td>21-369 Numerical Methods 9</td>
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<tr>
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<td>xx-xxx Depth Elective 9</td>
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<td>xx-xxx H&amp;SS Elective 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Free Elective 9</td>
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</table>

#### Senior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>xx-xxx Depth Elective 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx H&amp;SS Elective 9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Free Elective 9</td>
</tr>
</tbody>
</table>

Minimum number of units required for degree: 360

A student preparing for graduate study should also consider undertaking independent work. The Department offers 21-499 Undergraduate Research Topic and 21-599 Undergraduate Reading and Research for this purpose. These courses can be taken as part of satisfying the Depth Elective requirement, but require permission of both the instructor and the department.

Courses 21-700 and above can be used with the permission of both the instructor and the department.

MCS General Education (required)

MCS or SHS humanities, social sciences, and science core (114 units).

Students not in MCS are required to take 15-110 Principles of Computing (10 units).

Note that courses 21-600 and above carry graduate credit. 600 level courses are designed as transitional courses to graduate study.
### Double Major Requirements

All degrees offered by the Department are available as a second major to students majoring in other departments. Interested students should contact the Department for further information and guidance. In general the requirements for a second major include all the required courses except the MCS core, free electives and 21-201 Undergraduate Colloquium.

### The Minor in Mathematical Sciences

The Minor includes six courses: 21-127 Concepts of Mathematics is a prerequisite for 21-228 and recommended for 21-241. The minimum preparation required for 21-355 Principles of Real Analysis I is 21-120 /21-122 and 21-127 or equivalent courses.

21-127 Concepts of Mathematics 10
21-228 Discrete Mathematics 9-12
or 15-251 Great Theoretical Ideas in Computer Science
21-241 Matrices and Linear Transformations 9-10
or 21-242 Matrix Theory
or 21-341 Linear Algebra
21-355 Principles of Real Analysis I 9
21-3xx Mathematical Sciences Elective
21-3xx Mathematical Sciences Elective

To avoid excessive double counting, the two Mathematical Sciences Electives may not also count toward the student’s major.

A student who completes the Mathematical Studies sequence plus two recommended electives (typically 21-470 Selected Topics in Analysis and 21-374 Field Theory) will receive a Minor in Mathematical Sciences.

### The Minor in Discrete Mathematics and Logic

This minor develops the fundamentals of discrete mathematics and logic necessary to understand the mathematical foundations of many computer related disciplines. Required courses are:

21-300 Basic Logic 9
21-301 Combinatorics 9
21-341 Linear Algebra 9
21-484 Graph Theory 9

Two of the following:
21-329 Set Theory 9
21-373 Algebraic Structures 9
21-374 Field Theory 9
21-441 Number Theory 9
21-602 Introduction to Set Theory I 12
21-603 Model Theory I 12
21-610 Algebra I 12
21-700 Mathematical Logic II 12

### The Honors Degree Program

This demanding program leads to an M.S. in Mathematical Sciences, normally in four years, in addition to the student’s B.S. degree. The key element in the program is usually the Mathematical Studies sequence. Admission to the Honors Program, in the Junior year, requires an application. In the application process the Department will hold to the same high standards which apply to admission to any graduate program.

The core undergraduate honors courses are:

#### Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-242</td>
<td>(Honors version of 21-241 Matrices and Linear Transformations)</td>
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#### Sophomore Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-235</td>
<td>(Honors version of 21-355 Principles of Real Analysis I)</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>21-236</td>
<td>(Honors version of 21-355 Principles of Real Analysis I)</td>
</tr>
</tbody>
</table>

### Honors Program Requirements:

21-901 Masters Degree Research Var.

Five graduate mathematics courses: 60 units

Each student in the honors degree program will have a thesis advisor in addition to his or her academic advisor. In practice, the student must start thinking about the thesis as early as possible. For this reason we include some thesis work, 3 units of 21-901 Masters Degree Research, in the Fall semester of the Senior year to allow for exploratory work under supervision. The actual thesis work is then planned for the final semester with 15 units of 21-901 Masters Degree Research. The student must give a public presentation and will be examined on the thesis and related mathematics.

The five graduate courses must include at least one course from each of the following areas:

- Analysis: for example, Measure and Integration, Complex Analysis, Functional Analysis

### Faculty

PETER B. ANDREWS, Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1963–.

JEREMY AVIGAD, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 1996–.

EGON BALAS, University Professor – Ph.D., University of Brussels; Carnegie Mellon, 1968–.

ALBERT A. BLANK, Emeritus – Ph.D., New York University; Carnegie Mellon, 1969–.

IRINA GHEORGHIUCIUC, Assistant Teaching Professor – Ph.D., University of Pennsylvania; Carnegie Mellon, 2007–.

CHARLES V. COFFMAN, Emeritus – Ph.D., Johns Hopkins University; Carnegie Mellon, 1999–.

TIMOTHY FLAHERTY, Assistant Teaching Professor – Ph.D., University of Pittsburgh.; Carnegie Mellon, 2005–.

MANUEL BLUM, University Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1999–.

HASAN DEMIRKOPARAN, Assistant Teaching Professor – Ph.D., Michigan State University; Carnegie Mellon, 2005–.

DEBORAH BRANDON, Associate Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991–.

GERARD CORNUEJOLS, University Professor – Ph.D., California Institute of Technology; Carnegie Mellon, 1978–.

THOMAS BOHMAN, Professor – Ph.D., University of Maryland; Carnegie Mellon, 1972–.

ALAN M. FRIEZE, Professor – Ph.D., University of London; Carnegie Mellon, 1987–.

EGON BALAS, University Professor – Ph.D., University of Brussels; Carnegie Mellon, 1996–.

MCS core, free electives and 21-201 Undergraduate Colloquium.
RAMI GROSSBERG, Professor – Ph.D., Hebrew University of Jerusalem; Carnegie Mellon, 1988–.
MORTON E. GURTIN, Emeritus – Ph.D., Brown University; Carnegie Mellon, 1966–.
SIMI HABER, Nehari Visiting Assistant Professor – Ph.D., Tel Aviv University; Carnegie Mellon, 2011–.
DAVID HANDRON, Associate Teaching Professor – Ph.D., Rice University; Carnegie Mellon, 1999–.
JUDY HOLDENER, Shelly Visiting Professor – Ph.D., University of Illinois; Carnegie Mellon, 2012–.
WILLIAM J. HRUSA, Professor – Ph.D., Brown University; Carnegie Mellon, 1982–.
JOSE IOVINO, Visiting Associate Professor – Ph.D., University of Illinois; Carnegie Mellon, 2012–.
GAUTAM IYER, Assistant Professor – Ph.D., University of Chicago; Carnegie Mellon, 2009–.
GREGORY JOHNSON, Visiting Assistant Professor – Ph.D., University of Maryland; Carnegie Mellon, 2009–.
DMITRY KRAMKOV, Professor – Ph.D., Steklov Mathematical Institute; Carnegie Mellon, 2000–.
KASPER LARSEN, Assistant Professor – Ph.D., University of Southern Denmark; Carnegie Mellon, 2007–.
JOHN P. LEHOCZKY, Professor – Ph.D., Stanford University; Carnegie Mellon, 1969–.
GIOVANNI LEONI, Professor – Ph.D., University of Minnesota; Carnegie Mellon, 2002–.
PO-SHEN LOH, Assistant Professor – Ph.D., Princeton University; Carnegie Mellon, 2009–.
JOHN MACKNEY, Teaching Professor – Ph.D., University of Hawaii; Carnegie Mellon, 2003–.
DANIELA MIHAI, Assistant Teaching Professor – Ph.D., University of Pittsburgh; Carnegie Mellon, 2007–.
RICHARD A. MOORE, Emeritus – Ph.D., Washington University; Carnegie Mellon, 1956–.
ROY A. NICOLAIDES, Professor – Ph.D., University of London; Carnegie Mellon, 1984–.
WALTER NOLL, Emeritus – Ph.D., Indiana University; Carnegie Mellon, 1956–.
MARION L. OLLIVER, Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004–.
DAVID R. OWEN, Emeritus – Ph.D., Brown University; Carnegie Mellon, 1967–.
ROBERT L. PEGO, Professor – Ph.D., University of California at Berkeley; Carnegie Mellon, 2004–.
MICHAEL PICOLLELLI, Shelly Visiting Assistant Professor – Ph.D., Carnegie Mellon; Carnegie Mellon, 2012–.
AGOSTON PISZTORA, Associate Professor – Ph.D., ETH Zurich; Carnegie Mellon, 1996–.
SCOTT ROBERTSON, Assistant Professor – Ph.D., Boston University; Carnegie Mellon, 2011–.
JOHN W. SCHAFFER, Professor – Ph.D., Indiana University; Carnegie Mellon, 1983–.
JUAN J. SCHAFFER, Professor – Ph.D., Universitt Zrich; Carnegie Mellon, 1968–.
ERNST SCHIMMERLING, Professor – Ph.D., University of California at Los Angeles; Carnegie Mellon, 1998–.
DANA SCOTT, Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1981–.
ROBERT F. SEKERKA, University Professor – Ph.D., Harvard University; Carnegie Mellon, 1969–.
STEVEN E. SHREVE, Professor – Ph.D., University of Illinois; Carnegie Mellon, 1980–.
DEJAN SLEPCEV, Associate Professor – Ph.D., University of Texas at Austin; Carnegie Mellon, 2006–.
Physics, one of the basic sciences, has its origin in the irrepressible human curiosity to explore and understand the natural world. This fundamental urge to discover has led to the detailed understanding of a remarkable variety of physical phenomena. Our knowledge now encompasses the large-scale movement of galaxies, the minute motions within atoms and nuclei, and the complex structure of the assemblies of molecules that make life possible. The spectacular expansion of our comprehension of the physical world forms an impressive part of the intellectual and cultural heritage of our times. The opportunity to add to this heritage is an important source of motivation for young physicists. The application of discoveries in physics to the solution of complex modern technological problems offers a vast field in which physicists make decisive contributions. The interplay of pure and applied physics has always been fruitful and today ensures many rewarding career opportunities for physics students.

Carnegie Mellon’s undergraduate curriculum in physics has been carefully designed to provide a firm knowledge of the basic principles of physics, an appreciation of a wide range of physical problems of current interest, and the capacity to formulate and solve new problems. In addition to classwork and problem solving, the curriculum includes studying physical phenomena in the laboratory. Physics students are strongly encouraged to go beyond the formal theoretical and experimental course work and become involved in research projects under the guidance of individual faculty members.

Students may choose from a variety of degree options:

- B.S. in Physics
- B.A. in Physics
- B.S. in Physics with Tracks in:
  - Applied Physics
  - Astrophysics
  - Biological Physics
  - Chemical Physics
  - Computational Physics

The objectives and requirements for each of these options are described in the paragraphs below. Each allows considerable latitude in the choice of electives.

Through the judicious choice of elective courses, a double major program combining physics and another discipline can be readily achieved. A minor in physics is also offered for those students who major in other disciplines. The student, with the help of their faculty advisors, can easily build a program that aims at specific career objectives.

The Department maintains an active and wide-ranging program of advising. Beyond aiding in academic planning, the department advisors can also assist students in finding research work during the academic year, technical jobs and internships for the summer, as well as planning and executing the necessary steps for gaining employment or continuing their studies beyond the bachelor’s degree. Whether students follow a standard curriculum or not, they should consult their academic advisor at least once every semester.

### B.S. in Physics

B.S. degree candidates can choose studies in not only a wide variety of intermediate and advanced topics in physics but also a range of material in other science or engineering fields. The B.S. degree provides a solid foundation for students wishing to go on to graduate work in physics or any of a large number of fields in pure or applied science or engineering, for which a sound grasp of physics and mathematics is essential. This program also provides excellent preparation for careers in teaching, for work in industrial or governmental research and development, or for other employment in business or industry with a significant scientific component.

Degree Requirements are as follows:

- **Carnegie Mellon University Requirements**
- A minimum of 360 units is required.
- 99-101, 99-102, or 99-103 Computing @ Carnegie Mellon

### MCS Core Science Requirements

- 33-111 Physics I for Science Students or 33-131 Matter and Interaction I
- 33-112 Physics II for Science Students or 33-132 Matter and Interactions II
- 03-121 Modern Biology
- 09-105 Introduction to Modern Chemistry I
- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
- 76-101

### Distributional Course Requirements

- 1 course from Category 1: Cognition, Choice and Behavior (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
- 1 course from Category 2: Economic, Political and Social Institutions (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
- 1 course from Category 3: Cultural Analysis (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)

### Electives

- 4 non-technical courses (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts) of at least 9 units each from any of the departments in H&SS, CFA, or BA.

### Additional Core Physics/Math Courses

- 33-104 Experimental Physics
- 33-211 Physics III: Modern Essentials
- 33-228 Electronics I
- 33-231 Physical Analysis
- 33-232 Mathematical Methods of Physics
- 33-234 Quantum Physics
- 33-311 Physical Mechanics I
- 33-338 Intermediate Electricity and Magnetism I
- 33-340 Modern Physics Laboratory
- 33-341 Thermal Physics I
- 21-259 Calculus in Three Dimensions

### Physics Colloquium Courses

- 33-201 Physics Sophomore Colloquium I
- 33-202 Physics Sophomore Colloquium II
- 33-301 Physics Upperclass Colloquium I
- 33-302 Physics Upperclass Colloquium II

### Physics, Mathematics and Technical Electives

- 8 courses of at least 9 units each
- Allowed courses depend on track chosen: see below.

### Free Electives

- Approximately 26 units: actual number depends on track chosen and satisfying 360 total units
- A free elective is any Carnegie Mellon course; however, a maximum of 9 units of physical education and/or military science and/or StuCo courses may be taken as free electives.

We offer a Physics Major with or without a track. A track is like a “menu deal” at a fast-food restaurant: when one chooses a track, one gets...
a package of physics and other required courses and electives. The
specialized electives for each of the tracks are described below:

- **No Track** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/notrack)
- **Applied Physics** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/applyappliedphysicstrack)
- **Astrophysics** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/
astrophysicstrack)
- **Biological Physics** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/
bioapplicationstrack)
- **Chemical Physics** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/
chemicalphysicstrack)
- **Computational Physics** (https://coursecatalog-new.web.cmu.edu/
melloncollegeofscience/departmentofphysics/#bsinphysics/
computationphysicstrack)

A student does not need to choose a track but can follow the general, non-
track physics curriculum. You can also take all the courses that a track
requires without being in a track. You can declare, change, or leave your
track by discussing with the Assistant Head for Undergraduate Affairs.

Students planning to undertake graduate studies in physics are strongly
advised to take the following courses:

- **33-332 Physical Mechanics II**
- **33-339 Intermediate Electricity and Magnetism II**
- **33-445 Adv Quantum Physics I**
- **33-446 Advanced Quantum Physics II**

Qualifying electives in physics

The following courses qualify as specialized Physics Electives for the B.S.
and B.A. degrees and the Minor of Physics:

- **33-114 Physics of Musical Sound (B.A. and minor only)**
- **33-224 Stars, Galaxies and the Universe**
- **33-241 Introduction to Computational Physics**
- **33-332 Physical Mechanics II**
- **33-339 Intermediate Electricity and Magnetism II**
- **33-342 Thermal Physics II**
- **33-350 Undergraduate Research**
- **33-353 Intermediate Optics (Alt. Fall - F12, F14)**
- **33-355 Nanoscience and Nanotechnology (Alt. Fall - F13, F15)**
- **33-398 Special Topics**
- **33-441 Introduction to BioPhysics**
- **33-444 Introduction to Nuclear and Particle Physics (Alt. Spring - S13, S15)**
- **33-445 Adv Quantum Physics I**
- **33-446 Advanced Quantum Physics II**
- **33-448 Introduction to Solid State Physics**
- **33-451 Senior Research**
- **33-456 Advanced Computational Physics**
- **33-466 Extragalactic Astrophysics and Cosmology**
- **33-467 Astrophysics of Stars and the Galaxy**
- **33-499 Supervised Reading**
- **33-650 General Relativity**
- **33-658 Quantum Computation and Quantum Information Theory (Alt. Spring - S14, S16)**
- **33-7xx Physics Graduate Level Courses (see list below)**

Only one of the three courses - 33-350 (at least 9 units), 76-101 (at least 9
units), and 43-499 (at least 9 units) - may be used to satisfy as a Qualifying
Elective in Physics. Any exceptions must be pre-approved by the Assistant
Head for Undergraduate Affairs.

physics Graduate courses

- **33-755 Quantum Mechanics I**
- **33-756 Quantum Mechanics II**
- **33-758 Quantum Computation and Quantum Information Theory**
- **33-759 Introduction to Mathematical Physics I**
- **33-761 Classical Electrodynamics I**
- **33-762 Classical Electrodynamics II**

- **33-765 Statistical Mechanics**
- **33-767 Biophysics: From Basic Concepts to Current Research**
- **33-769 Quantum Mechanics III: Many Body and Relativistic Systems**
- **33-770 Field Theory I**
- **33-771 Field Theory II**
- **33-777 Introductory Astrophysics**
- **33-779 Introduction to Nuclear and Particle Physics**
- **33-780 Nuclear and Particle Physics II**
- **33-783 Solid State Physics**

**B.S. in Physics – Sample Schedule (No Track)**

**First Year**

**Fall**

- 33-111 Physics for Science Students 12
- 33-113 Matter and Interaction I 9
- 15-110 Principles of Computing 10-12
- 15-112 Fundamentals of Programming and Computer Science 10
- 21-120 Differential and Integral Calculus 10
- 99-101 Computing @ Carnegie Mellon 9
- 76-101 Interpretation and Argument (MCS Core 1 of 8) 9
- 99-101 Any course 9

**Spring**

- 33-112 Physics I for Science Students 12
- 33-132 Matter and Interactions II 9
- 33-104 Experimental Physics 9
- 21-122 Integration, Differential Equations and Approximation 9
- xx-xxx Humanities, Social Sciences, or Fine Arts Course (MCS Core 2 of 8) 9
- xx-xxx Any course 9

**Sophomore Year**

**Fall**

- 33-211 Physics II: Modern Essentials 10
- 33-231 Physical Analysis 10
- 33-251 Physics Sophomore Colloquium I 2
- 22-259 Calculus in Three Dimensions 9
- 09-105 Introduction to Modern Chemistry I 10
- xx-xxx Dietrich College/AF Course (MCS Core 3 of 8) 9

**Spring**

- 33-232 Mathematical Methods of Physics 10
- 33-228 Electronics I 10
- 33-234 Quantum Physics 10
- 33-252 Physics Sophomore Colloquium II 9
- 03-121 Modern Biology 9
- xx-xxx Dietrich College/AF Course (MCS Core 4 of 8) 9

**Junior Year**

**Fall**

- 33-331 Physical Mechanics I 10
- 33-338 Intermediate Electricity and Magnetism I 10
- 33-341 Thermal Physics I 10
- 33-301 Physics Sophomore Colloquium I 1
- xx-xxx Dietrich College/AF Course (MCS Core 5 of 8) 9
- xx-xxx Physics, Technical, or Free Elective (1 of 10) 9

**Spring**

- 33-340 Modern Physics Laboratory 10
- 33-302 Physics Sophomore Colloquium II 1
- xx-xxx Physics, Technical or Free Elective (2 of 10) 9
- xx-xxx Physics, Technical or Free Elective (3 of 10) 9
- xx-xxx Physics, Technical or Free Elective (4 of 10) 9
- xx-xxx Dietrich College/AF Course (MCS Core 6 of 8) 9

**Senior Year**

**Fall**

- 21-xxx Mathematics Elective 9
- xx-xxx Physics, Technical or Free Elective (5 of 10) 9
- xx-xxx Physics, Technical or Free Elective (6 of 10) 9
- xx-xxx Physics, Technical or Free Elective (7 of 10) 9
- xx-xxx Dietrich College/AF Course (MCS Core 7 of 8) 9

**Spring**

- xx-xxx Physics, Technical or Free Elective (8 of 10) 9
- xx-xxx Physics, Technical or Free Elective (9 of 10) 9
- xx-xxx Physics, Technical or Free Elective (10 of 10) 9
- xx-xxx Dietrich College/AF Course (MCS Core 8 of 8) 9
B.A. in Physics

The Bachelor of Arts degree in Physics offers a flexible program that allows students to combine the study of Physics with the opportunity to do intensive work in substantive areas such as liberal arts, teaching, business or law. With 82 units of free electives, it is feasible for students to obtain, for example, a double major with a department in the College of Humanities and Social Sciences, the College of Fine Arts, or the Tepper School of Business. It is expected that students will focus their elective courses in a well defined academic area. Students must meet with the Assistant Head for Undergraduate Affairs and construct an approved plan of study.

The requirements for the B.A. degree are the same as for the B.S. degree, except that the 8 Physics, Mathematics and Technical Electives in the B.S. program become Free Electives in the B.A. program.

Degree Requirements are as follows:

- Carnegie Mellon University Requirements
  - A minimum of 360 units is required.
  - 99-101, 99-102, or 99-103 Computing @ Carnegie Mellon

- MCS Core Science Requirements
  - 33-111 Physics I for Science Students or 33-131 Matter and Interaction I
  - 33-112 Physics II for Science Students or 33-132 Matter and Interactions II
  - 03-121 Modern Biology
  - 09-105 Introduction to Modern Chemistry I
  - 21-120 Differential and Integral Calculus
  - 21-122 Integration, Differential Equations and Approximation
  - MCS Core Courses must be completed by end of junior year.

- MCS Humanities & Social Sciences and Fine Arts Requirements (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - Common Course Requirement (Writing/Expression)
    - 76-101 Interpretation and Argument
  - Distributional Course Requirements
    - 1 course from Category 1: Cognition, Choice and Behavior (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
    - 1 course from Category 2: Economic, Political and Social Institutions (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
    - 1 course from Category 3: Cultural Analysis (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)

- Electives
  - 4 non-technical courses (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts) of at least 9 units each from any of the departments in H&SS, CFA, or BA.

- Additional Core Physics/Math Courses
  - 33-104 Experimental Physics (by fall of sophomore year)
  - 33-211 Physics III: Modern Essentials
  - 33-228 Electronics I
  - 33-231 Physical Analysis
  - 33-232 Mathematical Methods of Physics
  - 33-234 Quantum Physics
  - 33-331 Physical Mechanics I
  - 33-338 Intermediate Electricity and Magnetism I
  - 33-341 Thermal Physics I
  - 21-259 Calculus in Three Dimensions

- Physics Colloquium Courses
  - 33-201 Physics Sophomore Colloquium I
  - 33-202 Physics Sophomore Colloquium II
  - 33-301 Physics Upperclass Colloquium I
  - 33-302 Physics Upperclass Colloquium II

- Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingelectivesinphysics)
  - 2 courses of at least 9 units each

- Free Electives
  - Approximately 82 units: actual number depends on satisfying 360 total units
  - A free elective is any Carnegie Mellon course; however, a maximum of 9 units of physical education and/or military science and/or StuCo courses may be taken as free electives.

B.S. in Physics / No Track

The B.S. in Physics, Mathematics and Technical courses for the B.S. in the Physics without a track are as follows:

- Physics Electives
  - 4 courses of at least 9 unit each
    - must be chosen from the Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingelectivesinphysics)

- Math Elective
  - 1 course of at least 9 units
    - chosen from any 21-2xx or higher level courses except 21-350

- Technical Electives
  - 3 courses of at least 9 units each
    - Technical electives are any courses in MCS, SCS, Statistics, CIT, and others explicitly approved by the Assistant Head for Undergraduate Affairs.

B.S. in Physics / Applied Physics Track

The B.S. in Physics/Applied Physics Track is designed primarily for the student who wants to prepare for a career path that takes advantage of the diverse and expanding opportunities for employment in industrial and government laboratories with a B.S. degree. The program provides a solid foundation in the concepts of physics, as well as giving the student the experience and understanding of the application of these concepts. The track is intended to enhance computing and laboratory skills, and to introduce the application of physics to those subjects of particular interest to the student. Since the possible subject areas for study are so varied, the track will be tailored to each student’s needs within the framework described below.

The B.S. in Physics, Mathematics and Technical courses for the B.S. in the Applied Physics Track are as follows:

- Physics/Technical Courses
  - 33-44B Introduction to Solid State Physics
  - One course (at least 9 units) which strengthens the student’s ability to use the computer as a tool in the research environment
  - Two courses (at least 18 units), at least one of them in another department, which broaden the student’s laboratory skills
  - Two courses (at least 18 units), at least one of them in another department, which give the student experience in applying basic physics principles to a variety of problems
  - One research course: either 33-350 or 33-451
    - the research topic must be applied physics related and must be approved by the Assistant Head for Undergraduate Affairs.

- Math Elective
  - One course of at least 9 units
    - chosen from any 21-2xx or higher level course except 21-350.

Details of what may constitute the elective courses in the Physics/Technical Courses Requirement are decided after consultation with, and approved by, the Assistant Head for Undergraduate Affairs.

B.S. in Physics / Astrophysics Track

The B.S. in Physics/Astrophysics Track provides an option for those Physics majors who either want to specialize in this subfield or plan careers in astronomy or astrophysics. Career paths may include postgraduate training in astronomy or astrophysics or proceeding directly to jobs in these fields. The program provides a thorough foundation in the core physics program with electives concentrating in astrophysics.
The 8 Physics, Mathematics and Technical courses for the B.S. in the Astrophysics Track are as follows:

- **Astrophysics Courses**
  - 33-224 Stars, Galaxies and the Universe
  - 33-466 Extragalactic Astrophysics and Cosmology
  - 33-467 Astrophysics of Stars and the Galaxy
  - 1 research course: either 33-350 or 33-451
    - the research topic must be astrophysics related and must be approved by the Assistant Head for Undergraduate Affairs.

- **Math Elective**
  - 1 course of at least 9 units
    - chosen from any 21-2xx or higher level course except 21-350

- **Technical Electives**
  - 3 courses of 9 units each
    - Technical electives are any courses in MCS, SCS, Statistics, CIT, and others explicitly approved by the Physics Department.

**B.S. in Physics / Biological Physics Track**

The B.S. in Physics/Biological Physics Track combines a rigorous foundation in undergraduate physics with courses in Biological Physics and Chemistry. It is particularly suitable for students preparing for post-baccalaureate careers in the expanding areas of biological and medical physics or for graduate study in biophysics. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Biological Physics Track includes a number of courses which are also requirements for the pre-medical program. Students interested in both the Biological Physics Track and the pre-medical program should consult the requirements for the pre-medical program. Students interested in both chemical physics or chemistry. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Biological Physics Track includes a number of courses which are also requirements for the pre-medical program. Students interested in both the Biological Physics Track and the pre-medical program should consult the requirements for the pre-medical program. Students interested in both chemical physics or chemistry. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Biological Physics Track are as follows:

- **Physics Courses**
  - 33-441/03-439 Introduction to Biophysics
  - One course of at least 9 units
    - must be chosen from the Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingelectivesinphysics)

- **Math Elective**
  - One course of at least 9 units
    - chosen from any 21-2xx or higher level course except 21-350.

- **Biological Sciences/Chemistry Courses**
  - 03-231 Biochemistry I
  - 09-217 Organic Chemistry I
  - 09-218 Organic Chemistry II
  - 2 courses (18 units) in Biological Sciences

Details of what may constitute the elective courses in Biological Sciences are decided after consultation with, and approved by, the Assistant Head for Undergraduate Affairs.

**B.S. in Physics / Chemical Physics Track**

The B.S. in Physics/Chemical Physics Track is designed for students wishing to have a strong grounding in physics along with a specialization in physical chemistry and/or chemical physics. It is particularly suitable for those students planning on graduate studies in physics with an emphasis on chemical physics or chemistry. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Chemical Physics Track incorporates a number of courses which are also requirements for the pre-medical program. Students interested in both the Chemical Physics Track and the pre-medical program should consult both with their Physics Department advisor and the Director of the Health Professions Program for help in planning their programs.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Chemical Physics Track are as follows:

- **Physics Course**
  - One course of at least 9 units
    - must be chosen from the Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingelectivesinphysics)

- **Math Elective**
  - One course of at least 9 units
    - chosen from any 21-2xx or higher level course except 21-350.

- **Chemistry Courses**
  - 09-105 Modern Chemistry II
  - 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry
  - 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry
  - 3 courses (27 units) in Chemistry

Details of what may constitute the elective courses in Chemistry are decided after consultation with, and approved by, the Assistant Head for Undergraduate Affairs.

**B.S. in Physics / Computational Physics Track**

The B.S. in Physics/Computational Physics Track is intended to fill the increasing demand for physics graduates who are skilled in computational and numerical techniques which are used in the analysis of physical problems and in subjects ranging from control and real-time programming to software engineering and compiler and operating systems design. The degree provides the student with a rigorous grounding in physics as well as in the foundations and practice of computer use as applied to scientific problems. Work is done on machines ranging from high level workstations through supercomputers.

The track program includes additional courses from the Mathematics and Computer Science Departments as well as special courses in computational physics from the Physics Department. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Computational Physics Track are as follows:

- **Physics Courses**
  - 33-241 Introduction to Computational Physics
  - 33-456 Advanced Computational Physics
  - Two courses of at least 9 units each
    - Must be chosen from the Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingelectivesinphysics)

- **Mathematics and Computer Science Courses**
  - 21-127 Concepts of Mathematics
  - 21-369 Numerical Methods
  - 15-122 and 15-150
  - However, the student must check with the Assistant Head for Undergraduate Affairs for the latest required Computer Science courses for this track.

**A Double Major or a Dual Degree in Physics with a Degree in another Department**

Physics may be taken as a second major or for a second degree, with another department granting the primary degree. The rules of the Physics Department for these two options are distinct, as discussed below.

**Double Major**

In order to receive a Double Major in Physics, with another department granting the primary degree — with a B.S. or B.A., alone or with any track —
all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled except:

- No units of Technical Electives are required
- No units of Free Electives are required
- No H&SS/FA courses are required
- The following courses in the MCS core are not required: 03-121 Modern Biology, 09-105 Introduction to Modern Chemistry I
- However, 15-110 Principles of Computing or 15-112 Fundamentals of Programming and Computer Science (or equivalent as pre-approved by the Associate Dean of Mellon College of Science) is still required.

Dual Degree

In order to receive a Dual Degree in another subject and Physics, with another department granting the primary degree — with a B.S. or B.A. alone or with any track — all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled. The non-technical requirement is as per the Mellon College of Science; however, any course used for another department’s or college’s core requirement may be double counted for this purpose. The number of units required is 90 more than the total units required by the department requiring the fewer total units.

Minor in Physics

The Minor in Physics is designed to provide a solid foundation in physics at the introductory level, followed by elective courses which will familiarize the student with areas of modern physics, and the concepts and techniques employed therein. The Physics minor requires seven courses of at least 9 units each, of which four are required and three are electives.

- **Required Courses**
  - Introductory Physics I (one of 33-106, 33-111, 33-131)
  - Introductory Physics II (one of 33-107, 33-112, 33-132)
  - Physics III: Modern Essentials (33-211)
  - Experimental Physics (33-104)

- **Electives**
  - 3 physics electives, chosen from the Qualifying Physics Electives list (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentsofphysics/qualifyingelectivesinphysics)
  - choice requires prior approval by the Assistant Head for Undergraduate Affairs

The minor is open to all students of the university, although students with non-calculus based majors should be aware of the mathematics requirements for many physics courses (21-120, 21-122, 21-259).

Faculty

ROY A. BRIERE, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1999–.

RUPERT CROFT, Associate Professor of Physics – Ph.D., Oxford University; Carnegie Mellon, 2001–.

MARKUS DESERNO, Associate Professor of Physics – Ph.D., University of Mainz, Germany; Carnegie Mellon, 2007–.

TIZIANA DI MATTEO, Associate Professor of Physics – Ph.D., University of Cambridge; Carnegie Mellon, 2004–.

ALEX EVILEVITCH, Associate Professor of Physics – Ph.D., Lund University, Sweden; Carnegie Mellon, 2009–.

RANDALL M. FEENSTRA, Professor of Physics – Ph.D., California Institute of Technology; Carnegie Mellon, 1995–.

THOMAS A. FERGUSON, Professor of Physics – Ph.D., University of California at Los Angeles; Carnegie Mellon, 1985–.

GREGG B. FRANKLIN, Professor of Physics; Head, Department of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1984–.

STEPHEN GAROFF, Professor of Physics; Associate Head, Department of Physics – Ph.D., Harvard University; Carnegie Mellon, 1988–.

KUNAL GHOSH, Teaching Professor of Physics, Assistant Head for Undergraduate Affairs, Department of Physics – Ph.D., Iowa State University; Carnegie Mellon, 2001–.

FREDERICK J. GILMAN, Buhl Professor of Physics; Dean, Mellon College of Science – Ph.D., Princeton University; Carnegie Mellon, 1995–.

RICHARD E. GRIFFITHS, Professor of Physics – Ph.D., University of Leicester, U.K.; Carnegie Mellon, 1996–.

ROBERT B. GRIFFITHS, University Professor & Otto Stern Professor of Physics – Ph.D., Stanford University; Carnegie Mellon, 1964–.

FRANK HEINRICH, Assistant Professor of Physics – Ph.D., University of Leipzig, Germany; Carnegie Mellon, 2011–.

SHIRLEY HO, Assistant Professor of Physics – Ph.D., Princeton University; Carnegie Mellon, 2012–.

RICHARD F. HOLMAN, Professor of Physics – Ph.D., Johns Hopkins University; Carnegie Mellon, 1987–.

GEORGE KLEIN, Associate Teaching Professor of Physics – Ph.D., New York University; Carnegie Mellon, 1993–.

MICHAEL J. LEVINE, Professor of Physics, Director of Pittsburgh Supercomputer Center – Ph.D., California Institute of Technology; Carnegie Mellon, 1968–.

MATHIAS LOSCHE, Professor of Physics – Ph.D., Technical University of Munich; Carnegie Mellon, 2005–.

BARRY B. LUOKKALA, Teaching Professor of Physics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1980–.

SARA A. MAJETICH, Professor of Physics – Ph.D., University of Georgia; Carnegie Mellon, 1990–.

RACHEL MANDELBAAUM, Assistant Professor of Physics – Ph.D., Princeton University; Carnegie Mellon, 2012–.

CURTIS A. MEYER, Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1993–.

COLIN J. MORNINGSTAR, Professor of Physics – Ph.D., University of Toronto; Carnegie Mellon, 2000–.

JOHN F. NAGLE, Professor of Physics and Biological Sciences – Ph.D., Yale University; Carnegie Mellon, 1967–.

MANFRED PAULUNI, Professor of Physics – Ph.D., University of Erlangen, Germany; Carnegie Mellon, 2000–.

JEFFREY B. PETERSON, Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1993–.

BRIAN P. QUINN, Professor of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1998–.

IRA Z. ROTHSTEIN, Professor of Physics – Ph.D., University of Maryland at College Park; Carnegie Mellon, 1997–.

JAMES S. RUSS, Professor of Physics – Ph.D., Princeton University; Carnegie Mellon, 1967–.

REINHARD A. SCHUMACHER, Professor of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1987–.

ROBERT M. SUTER, Professor of Physics – Ph.D., Clark University; Carnegie Mellon, 1981–.

ROBERT H. SWENDESEN, Professor of Physics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1984–.

HY TRAC, Assistant Professor of Physics – Ph.D., University of Toronto; Carnegie Mellon, 2010–.

STEPHANIE TRISTRAM-NAGLE, Research Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992–.

HELMUT VOGEL, Professor of Physics – Ph.D., University of Erlangen-Nuremberg; Carnegie Mellon, 1983–.

MICHAEL WIDOM, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1985–.

KRISTINA WOODS, Assistant Professor of Physics – Ph.D., Stanford University; Carnegie Mellon, 2007–.

DI XIAO, Assistant Professor of Physics – Ph.D., University of Texas, Austin; Carnegie Mellon, 2012–.

Emeriti Faculty

LUIC BERGER, Professor of Physics, Emeritus – Ph.D., University of Lausanne, Switzerland; Carnegie Mellon, 1960–.

RICHARD M. EDELSTEIN, Professor of Physics, Emeritus – Ph.D., Columbia University; Carnegie Mellon, 1960–.

ARNOLD ENGLER, Professor of Physics, Emeritus – Ph.D., University of Berne, Switzerland; Carnegie Mellon, 1962–.
JOHN G. FETKOVICH, Professor of Physics, Emeritus – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1959–.
LEONARD S. KISSINGER, Professor of Physics, Emeritus – Ph.D., Indiana University; Carnegie Mellon, 1969–.
ROBERT W. KRAEMER, Professor of Physics, Emeritus – Ph.D., Johns Hopkins University; Carnegie Mellon, 1965–.
LING-FONG LI, Professor of Physics, Emeritus – Ph.D., University of Pennsylvania; Carnegie Mellon, 1974–.
JOHN A. RAYNE, Professor of Physics, Emeritus – Ph.D., University of Chicago; Carnegie Mellon, 1963–.
ROBERT T. SCHUMACHER, Professor of Physics, Emeritus – Ph.D., University of Illinois; Carnegie Mellon, 1957–.
ROBERT F. SEKERKA, University Professor of Physics and Mathematics, Emeritus – Ph.D., Harvard; Carnegie Mellon, 1969–.
NED S. VANDER VEN, Professor of Physics, Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1961–.
LINCOLN WOLFENSTEIN, University Professor of Physics, Emeritus – Ph.D., University of Chicago; Carnegie Mellon, 1948–.
HUGH D. YOUNG, Professor of Physics, Emeritus – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1956–.

Joint Appointments and Courtesy Appointments

SHELLEY ANNA, Associate Professor of Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 2003–.
DAVID GREVE, Professor of Electrical & Computer Engineering – Ph.D., Lehigh University; Carnegie Mellon, 1982–.
MOHAMMAD F. ISLAM, Assistant Professor of Materials Science & Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2005–.
CRAIG MALONEY, Assistant Professor of Civil and Environmental Engineering – Ph.D., University of California, Santa Barbara; Carnegie Mellon, 2007–.
MAUMITA MANDAL, Assistant Professor of Chemistry – Ph.D., Hyderabad, India; Carnegie Mellon, 2009–.
MICHAEL E. MCHENRY, Professor of Materials Science and Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.
ANTHONY D. ROLLETT, Professor of Materials Science & Engineering – Ph.D., Drexel University; Carnegie Mellon, 1995–.
JIANG-GANG ZHU, Professor of Electrical and Computer Engineering – Ph.D., University of California San Diego; Carnegie Mellon, 1997–.
School of Computer Science

Curriculum - B.S. in Computer Science

Computer Science Course: Units
15-128 Freshman Immigration Course 1
15-122 Principles of Imperative Computation 10
15-150 Principles of Functional Programming 10
15-210 Parallel and Serial Data Structures and Algorithms 12
15-213 Introduction to Computer Systems 12
15-251 Great Theoretical Ideas in Computer Science 12
15-451 Algorithm Design and Analysis 12

One Communications course: Units
15-221 Technical Communication for Computer Scientists 9

One Algorithms Complexity elective: Units
15-354 Computational Discrete Mathematics 12
15-355 Modern Computer Algebra 9
15-453 Formal Languages, Automata, and Computability 9
21-301 Combinatorics 9
21-484 Graph Theory 9

Mathematics/Probability
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations and Approximation 10
21-127 Concepts of Mathematics 10

One of the following Linear Algebra courses:
21-241 Matrices and Linear Transformations 10
21-242 Matrix Theory 10
21-243 Linear Algebra 9

One of the following Probability courses:
15-359 Probability and Computing 12
21-225 Probability 9
36-317 Probability Theory and Random Processes 9
36-225 Introduction to Probability Theory 9

Engineering and Natural Sciences
Four engineering or science courses are required, of which at least one must have a laboratory component and at least two must be from the same department. At present, courses meeting the lab requirement are:

09-101 Introduction to Chemical Engineering 3
15-321 Research Methods for Experimental Computer Science 9
27-100 Engineering the Materials of the Future 12
33-104 Experimental Physics 12
85-310 Research Methods in Cognitive Psychology 9

The following MCS and CIT courses cannot be used to satisfy the Engineering and Natural Sciences requirement:

09-103 Atoms, Molecules and Chemical Change 9
09-104 Fundamental Aspects of Organic Chemistry and Biochemistry 9
18-202 Mathematical Foundations of Electrical Engineering 12
19-101 Introduction to Engineering and Public Policy 12
33-100 Basic Experimental Physics 12
33-115 Physics for Future Presidents 9
33-124 Introduction to Astronomy 9
39-100 Special Topics: WHAT IS ENGINEERING? 9
39-200 Business for Engineers 9

NOTE: In the fall, 2010 semester, the Computer Science Department changed its introductory sequence by offering three new courses: 15-122, 15-150, 15-210, that replaced the old 15-121, 15-211, and 15-212, respectively. The focus of the new courses is on reasoning about programs (and programming) as much as it is on programming itself. Thus, the Fall 2010 (and beyond) curriculum requirements for the CS major have changed substantively from those in the past.
Humanities and Arts

All candidates for the bachelor’s degree must complete a minimum of 63 units offered by the College of Humanities & Social Sciences and/or the College of Fine Arts as prescribed below:

A. Writing Requirement (9 units)

Complete the following course:

76-101 Interpretation and Argument 9

B. Breadth Requirement (27 units)

Complete three courses, one each from Category 1, Category 2, and Category 3:

Category 1: Cognition, Choice and Behavior - this requirement explores the process of thinking, decision making, and behavior in the context of the individual.

70-311 Organizational Behavior 9
80-130 Introduction to Ethics 9
80-150 Nature of Reason 9
80-180 Nature of Language 9
80-221 Philosophy of Social Science 9
80-230 Ethical Theory 9
80-241 Ethical Judgments in Professional Life 9
80-270 Philosophy of Mind 9
80-275 Metaphysics 9
80-281 Language and Thought 9
81-102 Introduction to Psychology 9
85-211 Cognitive Psychology 9
85-221 Principles of Child Development 9
85-241 Social Psychology 9
85-251 Personality 9
85-261 Abnormal Psychology 9
88-120 Reason, Passion and Cognition 9
88-260 Organizations 9

Category 2: Economic, Political and Social Institutions - this requirement explores the processes by which institutions organize individual preferences and actions into collective outcomes.

18-101 Introduction to Engineering and Public Policy 12
36-303 Sampling, Survey and Society 9
70-332 Business, Society and Ethics 9
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
79-331 Body Politics: Women and Health in America 9
79-335 Drug Use and Drug Policy 9
80-135 Introduction to Political Philosophy 9
80-136 Social Structure, Public Policy & Ethics 9
80-235 Political Philosophy 9
80-243 Business Ethics 6
80-244 Environmental Ethics 9
80-245 Medical Ethics 9
80-341 Computers, Society and Ethics 9
88-104 Decision Processes in American Political Institutions 9
88-110 Experiments with Economic Principles 9
88-205 Comparative Politics 9
88-220 Policy Analysis I 9
88-326 Theories of International Relations 9

Category 3: Cultural Analysis - this requirement seeks to recognize cultures that have shaped and continue to shape the human experience; courses in this category are usually either broad in place, time, or cultural diversity.

57-173 Survey of Western Music History 9
60-205 Modern Visual Culture 1789-1945 9
70-342 Managing Across Cultures 9
76-227 Comedy 9
76-232 African American Literature 9
76-239 Introduction to Film Studies 9
76-241 Introduction to Gender Studies 9
79-104 Global Histories 9
79-113 Culture and Identity in American Society 9
79-207 Development of European Culture 9
79-222 Between Revolutions: The Development of Modern Latin America 9
79-226 Introduction to African History: Earliest Times to 1870 9
79-240 The Development of American Culture 9
79-241 African American History: Africa to the Civil War 9
79-242 Topics in African American History: Reconstruction to the Present 9
79-255 Irish History 9
79-261 Chinese Culture and Society 9
79-281 Introduction to Religion 9
79-311 Introduction to Anthropology 9
79-345 The Roots of Rock and Roll, 1870-1970 9
79-350 Early Christianity 9
79-368 Poverty, Charity, and Welfare 9
80-100 Introduction to Philosophy 9
80-250 Ancient Philosophy 9
80-251 Modern Philosophy 9

B.0.253 Continental Philosophy 9
B.0.254 Analytic Philosophy 9
B.0.255 Pragmatism 9
B.0.261 Empiricism and Rationalism 9
B.0.276 Philosophy of Religion 9
B.2-273 Introduction to Japanese Language and Culture 9
B.2-293 Introduction to Russian Culture 9
B.2-303 French Culture 9
B.2-304 The Francophone World 9
B.2-333 Introduction to Chinese Language and Culture 9
B.3-342 Spain: Language and Culture 9
B.3-343 Latin America: Language and Culture 9
B.3-344 U.S. Latinos: Language and Culture 9
B.3-345 Introduction to Hispanic Literary and Cultural Studies 9

C. Humanities and Arts Electives (27 units)

Complete 3 non-technical courses of at least 9 units each from any of the departments in the College of Humanities & Social Sciences or the College of Fine Arts or from the Department of Business Administration. Some of the courses taught in these units are considered technical courses and may not be used to satisfy this requirement. The complete list of additions and deletions can be found at http://www.csd.cs.cmu.edu/education(bsc/humanities-arts.html).

Required Minor

A sequence of courses prescribed by the requirements of the particular department. Completion of a second major (or double degree) also satisfies this requirement. If permitted by the minor or second major department, courses taken in satisfaction of the minor or second major may also count toward any category other than Computer Science.

Computing @ Carnegie Mellon

The following course is required of all students to familiarize them with the campus computing environment:

99-10x Computing @ Carnegie Mellon 3

Free Electives

A free elective is any Carnegie Mellon course. However, a maximum of nine units of Physical Education and/or Military Science (ROTC) and/or Student-Led (StuCo) courses may be used toward fulfilling graduation requirements.

Summary of Degree Requirements:

<table>
<thead>
<tr>
<th>Area</th>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>13</td>
<td>135</td>
</tr>
<tr>
<td>Math/Statistics</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>Engineering/Science</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Humanities/Arts</td>
<td>7</td>
<td>63</td>
</tr>
<tr>
<td>Minor/Free electives</td>
<td>7</td>
<td>75</td>
</tr>
<tr>
<td>Computing @ Carnegie Mellon</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td></td>
</tr>
</tbody>
</table>

Suggested Course Sequence

Freshman Year:

Fall Units
15-122 Principles of Imperative Computation 10
15-128 Freshman Immigration Course 1
21-120 Differential and Integral Calculus 10
21-127 Concepts of Mathematics 10
76-101 Interpretation and Argument 9
99-10x Computing Skills Workshop 3
xx-xx Science/Engineering Course 9
52

Spring Units
15-150 Principles of Functional Programming 10
15-251 Great Theoretical Ideas in Computer Science 12
21-122 Integration, Differential Equations and Approximation 10
xx-xx Science/Engineering Course 9
xx-xx Humanities and Arts Elective 9
50

Sophomore Year:

Fall Units
15-210 Parallel and Sequential Data Structures and Algorithms 12
21-241 Matrices and Linear Transformations 10
xx-xx Science/Engineering Course 9
### Spring Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-213</td>
<td>Introduction to Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>15-xxxx</td>
<td>Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxxx</td>
<td>Science/Engineering Course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities and Arts Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Minor Requirement / Free Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

### Junior Year:

#### Fall Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-451</td>
<td>Algorithm Design and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>15-xxxx</td>
<td>Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxxx</td>
<td>Probability Course</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities and Arts Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Minor Requirement / Free Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Spring Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-221</td>
<td>Technical Communication for Computer Scientists</td>
<td>9</td>
</tr>
<tr>
<td>15-xxxx</td>
<td>Computer Science Elective</td>
<td>12</td>
</tr>
<tr>
<td>15-xxxx</td>
<td>Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Minor Requirement / Free Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

### Senior Year:

#### Fall Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx</td>
<td>Computer Science Elective</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities and Arts Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Minor Requirement / Free Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Spring Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-xxxx</td>
<td>Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities and Arts Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Minor Requirement / Free Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

Minimum number of units required for the degree: 360

### Non-minor Elective Options

The flexibility in the curriculum allows many different schedules, of which the above is only one possibility. Students should consult with their academic advisors to determine the best elective options depending on their academic interests and career goals. In particular, the School of Computer Science offers a Double Major in Human-Computer Interaction as well as numerous computing-oriented Minors available to majors and non-majors alike. For students whose interests lie in other areas of Computer Science, we offer the following recommendations of elective choices that might be made for particular areas of interest. These are merely suggestions and are subject to change:

#### Artificial Intelligence

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-601</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>15-383</td>
<td>Artificial Intelligence: Representation and Problem Solving</td>
<td>9</td>
</tr>
<tr>
<td>15-384</td>
<td>Robotic Manipulation</td>
<td>12</td>
</tr>
<tr>
<td>15-385</td>
<td>Computer Vision</td>
<td>9</td>
</tr>
<tr>
<td>80-314</td>
<td>Logic and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Cognitive Modeling

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-432</td>
<td>Cognitive Modeling and Intelligent Tutoring Systems</td>
<td>Var.</td>
</tr>
<tr>
<td>85-213</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-392</td>
<td>Human Expertise</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Computer Systems

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-410</td>
<td>Operating System Design and Implementation</td>
<td>12</td>
</tr>
<tr>
<td>15-411</td>
<td>Compiler Design</td>
<td>12</td>
</tr>
<tr>
<td>15-412</td>
<td>Operating System Practice</td>
<td>1</td>
</tr>
<tr>
<td>15-418</td>
<td>Parallel Computer Architecture and Programming</td>
<td>12</td>
</tr>
<tr>
<td>15-441</td>
<td>Computer Networks</td>
<td>12</td>
</tr>
<tr>
<td>15-410</td>
<td>Engineering Distributed Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-240</td>
<td>Structure and Design of Digital Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-348</td>
<td>Embedded Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-447</td>
<td>Introduction to Computer Architecture</td>
<td>12</td>
</tr>
<tr>
<td>18-549</td>
<td>Embedded Systems Design</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Graphics

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-462</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>15-463</td>
<td>Computational Photography</td>
<td>12</td>
</tr>
<tr>
<td>15-464</td>
<td>Technical Animation</td>
<td>12</td>
</tr>
<tr>
<td>15-465</td>
<td>Animation Art and Technology</td>
<td>12</td>
</tr>
<tr>
<td>15-466</td>
<td>Computer Game Programming</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Theory

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-312</td>
<td>Foundations of Programming Languages</td>
<td>12</td>
</tr>
<tr>
<td>15-317</td>
<td>Constructive Logic</td>
<td>9</td>
</tr>
<tr>
<td>15-318</td>
<td>Computational Discrete Mathematics</td>
<td>12</td>
</tr>
<tr>
<td>15-355</td>
<td>Modern Computer Algebra</td>
<td>9</td>
</tr>
<tr>
<td>15-414</td>
<td>Bug Catching: Automated Program Verification and Testing</td>
<td>9</td>
</tr>
<tr>
<td>15-403</td>
<td>Formal Languages, Automata, and Computability</td>
<td>9</td>
</tr>
<tr>
<td>21-341</td>
<td>Linear Algebra</td>
<td>9</td>
</tr>
<tr>
<td>21-355</td>
<td>Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-373</td>
<td>Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-374</td>
<td>Field Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-441</td>
<td>Number Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-600</td>
<td>Mathematical Logic I</td>
<td>12</td>
</tr>
</tbody>
</table>

### Senior Research Thesis

Students considering going on to graduate school in Computer Science should take a wide variety of Computer Science and Mathematics courses, as well as consider getting involved in independent research as early as possible. This would be no later than the junior year and can begin even earlier. Students interested in grad school should also consider participating in the Senior Research Thesis program. Additionally, graduate CS courses can be taken with permission of the instructor.

The goal of the Senior Research Thesis Program is to introduce students to the breadth of tasks involved in independent research, including library work, problem formulation, experimentation, and writing and speaking. In particular, students present a brief midterm progress report each semester, present a public poster session in December, present an oral summary in the year-end university-wide Undergraduate Research Symposium and submit a written thesis in May. Students work closely with faculty advisors to plan and carry out their projects. Projects span the entire senior year, and students receive 18 units of academic credit each semester. Nine of these 18 can be counted toward CS elective requirements, and nine as free elective credits; hence, for most students, the thesis program replaces two courses per semester.

### SCS Additional Majors and Minors

The School of Computer Science offers an Additional Major in Computer Science, Human-Computer Interaction, and Robotics. It also offers Minors in Computer Science, Computational Biology, Language Technologies, Neural Computation, Robotics, and Software Engineering.

#### Computer Science Additional Major

The following courses are required for the Additional Major in Computer Science:

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td>12</td>
</tr>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>15-150</td>
<td>Principles of Functional Programming</td>
<td>12</td>
</tr>
<tr>
<td>21-320</td>
<td>Differential and Integral Calculus</td>
<td>12</td>
</tr>
<tr>
<td>21-322</td>
<td>Integration, Differential Equations and Approximation</td>
<td>12</td>
</tr>
<tr>
<td>21-327</td>
<td>Concepts of Mathematics</td>
<td>12</td>
</tr>
<tr>
<td>15-210</td>
<td>Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>15-213</td>
<td>Introduction to Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>15-215</td>
<td>Great Theoretical Ideas in Computer Science</td>
<td>12</td>
</tr>
<tr>
<td>15-451</td>
<td>Algorithm Design and Analysis</td>
<td>12</td>
</tr>
</tbody>
</table>

One of the following Linear Algebra courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>21-242</td>
<td>Matrix Theory</td>
<td>10</td>
</tr>
<tr>
<td>21-341</td>
<td>Linear Algebra</td>
<td>9</td>
</tr>
</tbody>
</table>

One of the following Probability courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-359</td>
<td>Probability and Computing</td>
<td>12</td>
</tr>
<tr>
<td>21-325</td>
<td>Probability</td>
<td>9</td>
</tr>
<tr>
<td>36-217</td>
<td>Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
<td>9</td>
</tr>
</tbody>
</table>
The computational biology minor is open to students in any major of any college at Carnegie Mellon. The curriculum and course requirements are designed to maximize the participation of students from diverse academic disciplines. The program seeks to produce students with both basic computational skills and knowledge in biological sciences that are central to computational biology.

Why Minor in Computational Biology?
Computational Biology is concerned with solving biological and biomedical problems using mathematical and computational methods. It is recognized as an essential element in modern biological and biomedical research. There have been fundamental changes in biology and medicine over the past two decades due to spectacular advances in high throughput data collection for genomics, proteomics and biomedical imaging. The resulting availability of unprecedented amounts of biological data demands the application of advanced computational tools to build integrated models of biological systems, and to use them to devise methods of prevent or treat disease. Computational Biologists inhabit and expand the interface of computation and biology, making them integral to the future of biology and medicine.

A minor in Computational Biology will position students well for entering the job market and graduate school in this exciting and growing field.

Admission
Students must apply for admission no later than November 30 of their senior years; an admission decision will usually be made within one month. Students are encouraged to apply as early as possible in their undergraduate careers so that the advisor of the computational biology minor can provide advice on their curriculum.

To apply, send email to Dr. Ziv Bar-Joseph <zivb at andrew.cmu.edu> and Dr. Karen Thichman <krtiochman at cmu.edu>. Include in your email:

- Full name
- Andew ID
- Preferred email address (if different)
- Your class and College/School at Carnegie Mellon
- Semester you intend to graduate
- All (currently) declared majors and minors
- Statement of purpose (maximum 1 page) — Describes why you want to take this minor and how it fits into your career goals
- Proposed schedule of courses for the minor (this is your plan, NOT a commitment)

Curriculum
The minor in computational biology requires a total of five courses: 3 core courses, 1 biology elective, and 1 computer science elective, for a total of 45 units.

Course List

### Prerequisites

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>15-322</td>
<td>Principles of Imperative Computation</td>
<td>10</td>
</tr>
</tbody>
</table>

### Course List

#### Core Classes

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-250</td>
<td>Introduction to Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>02-261</td>
<td>Quantitative Cell and Molecular Biology Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>plus one of the following courses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02-510</td>
<td>Computational Genomics</td>
<td>12</td>
</tr>
<tr>
<td>02-512</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
<td>9</td>
</tr>
<tr>
<td>02-530</td>
<td>Cells and Systems Modeling</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Course List

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-231</td>
<td>Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-325</td>
<td>Evolution</td>
<td>9</td>
</tr>
<tr>
<td>03-330</td>
<td>Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-380</td>
<td>Virology</td>
<td>9</td>
</tr>
<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
<td>9</td>
</tr>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
<td>9</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
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</table>

### Course List

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-422</td>
<td>Advanced Algorithms for Computational Structural Biology</td>
<td>9</td>
</tr>
<tr>
<td>02-450</td>
<td>Automation of Biological Research</td>
<td>9</td>
</tr>
<tr>
<td>02-500</td>
<td>Under Graduate Research in Computational Biology</td>
<td>9</td>
</tr>
<tr>
<td>02-530</td>
<td>Computational Genomics</td>
<td>12</td>
</tr>
<tr>
<td>02-512</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
<td>9</td>
</tr>
<tr>
<td>02-530</td>
<td>Cells and Systems Modeling</td>
<td>12</td>
</tr>
<tr>
<td>02-740</td>
<td>Bioimage Informatics</td>
<td>9</td>
</tr>
<tr>
<td>09-560</td>
<td>Computational Chemistry</td>
<td>12</td>
</tr>
</tbody>
</table>
Double Counting of Courses
SCS undergraduates may use 11-721 Grammars and Lexicons as an elective for their CS degree and also as a required course for the LT minor. Courses in the minor may not be counted towards another SCS minor.

Machine Learning Minor
Chair: William W. Cohen
E-mail: ml-minor@cs.cmu.edu
Website: http://www.ml.cmu.edu/prospective-students/minor-in-machine-learning.html

Machine learning and statistical methods are increasingly used in many application areas including natural language processing, speech, vision, robotics, and computational biology. The Minor in Machine Learning allows undergraduates to learn about the core principles of this field.

Prerequisites

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>21-322</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>36-217</td>
<td>Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>36-225</td>
<td>Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>36-325</td>
<td>Probability</td>
<td>9</td>
</tr>
<tr>
<td>36-359</td>
<td>Probability and Computing</td>
<td>9</td>
</tr>
</tbody>
</table>

Core Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-401</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>10-701</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>36-401</td>
<td>Modern Regression</td>
<td>9</td>
</tr>
</tbody>
</table>

Electives

Total of 3 courses (36 units) from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-701</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>10-xxx</td>
<td>certain ML grad courses as specified on the Minor web page</td>
<td></td>
</tr>
<tr>
<td>10-xxx</td>
<td>year-long supervised research</td>
<td></td>
</tr>
<tr>
<td>36-315</td>
<td>Statistical Graphics and Visualization</td>
<td>9</td>
</tr>
<tr>
<td>36-402</td>
<td>Advanced Data Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-462</td>
<td>Topics in Statistics:</td>
<td>9</td>
</tr>
<tr>
<td>36-463</td>
<td>Multilevel and Hierarchical Models</td>
<td>9</td>
</tr>
<tr>
<td>36-464</td>
<td>Topics in Statistics: Applied Multivariate Methods</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional electives can be found on the minor electives page (http://www.ml.cmu.edu/prospective-students/minor-electives.html).

Double Counting

Any course in the Machine Learning minor, other than the prerequisites, may not be counted towards another SCS minor.

Neural Computation Minor

Director: Dr. Tai Sing Lee
Administrative Coordinator: Melissa Stupka
Website: http://www.cnbc.cmu.edu/upnc/nic_minor/

The minor in Neural Computation is an intercollege minor jointly sponsored by the School of Computer Science, the Mellon College of Science, and the Dietrich College of Humanities and Social Sciences, and is coordinated by the Center for the Neural Basis of Cognition (CNBC) (http://www.cnbc.cmu.edu).

The Neural Computation minor is open to students in any major of any college at Carnegie Mellon. It seeks to attract undergraduate students from computer science, psychology, engineering, biology, statistics, physics, and mathematics from SCS, CIT, Dietrich College and MCS. The primary objective of the minor is to encourage students in biology and psychology to take computer science, engineering and mathematics courses on the one hand, and to encourage students in computer science, engineering, statistics and physics to take courses in neuroscience and psychology on the other, and to bring students from different disciplines together to form a community. The curriculum and course requirements are designed to maximize the participation of students from diverse academic disciplines. The program seeks to produce students with both basic computational skills and knowledge in cognitive science and neuroscience that are central to computational neuroscience.

Curriculum

The minor in Neural Computation will require a total of five courses: four courses drawn from the four core areas (A: neural computation, B: neuroscience, C: cognitive psychology, D: intelligent system analysis), one from each area, and one additional depth elective chosen from one of the core areas that is outside the student’s major. The depth elective can be replaced by a one-year research project in computational neuroscience. No more than two courses can be double counted toward the student’s major.

**Note:** Courses in the minor may not be counted towards another SCS minor.

Human-Computer Interaction Additional Major

The undergraduate major in HCI is available only as an additional major. If you have questions, please contact the Academic Program Coordinator at hcbachelors@cs.cmu.edu.

Human-Computer Interaction (HCI) is devoted to the design, implementation, and evaluation of interactive computer-based technology. Examples of HCI products include intelligent computer tutors, wearable computers, and highly interactive web sites. Constructing an HCI product is a cyclic, iterative process that involves at least three stages.

For full details on the Additional Major in Human-Computer Interaction, see Intercollege Programs (p. 62).

Language Technologies Minor

Chair: Alan W. Black
E-mail: awb@cs.cmu.edu
Website: http://www.lti.cs.cmu.edu/lti_minor

Human language technologies have become an increasingly central component of Computer Science in the last decade. Information retrieval, machine translation and speech technology are used daily by the general public, while text mining, natural language processing, and language-based tutoring are used regularly within more specialized professional or educational environments. The Language Technologies Minor allows students to learn about language technologies and apply them through a directed project.

Prerequisites

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-122</td>
<td>Principles of Imperative Computation</td>
<td>10</td>
</tr>
<tr>
<td>15-150</td>
<td>Principles of Functional Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-341</td>
<td>Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>36-217</td>
<td>Probability Theory and Random Processes</td>
<td>9</td>
</tr>
</tbody>
</table>

Curriculum

Core Course

11-721 Grammars and Lexicons 12

Electives (choose 3)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-492</td>
<td>Special Topic: Speech Processing</td>
<td>12</td>
</tr>
<tr>
<td>11-411</td>
<td>Natural Language Processing</td>
<td>12</td>
</tr>
<tr>
<td>11-441</td>
<td>Search Engines and Web Mining</td>
<td>12</td>
</tr>
<tr>
<td>11-711</td>
<td>Algorithms for NLP</td>
<td>12</td>
</tr>
<tr>
<td>11-731</td>
<td>Machine Translation</td>
<td>12</td>
</tr>
<tr>
<td>11-741</td>
<td>Information Retrieval</td>
<td>12</td>
</tr>
<tr>
<td>11-751</td>
<td>Speech Recognition and Understanding</td>
<td>12</td>
</tr>
<tr>
<td>11-752</td>
<td>Speech II: Phonetics, Prosody, Perception and Synthesis</td>
<td>12</td>
</tr>
<tr>
<td>11-761</td>
<td>Language and Statistics</td>
<td>12</td>
</tr>
<tr>
<td>80-180</td>
<td>Nature of Language</td>
<td>9</td>
</tr>
<tr>
<td>80-280</td>
<td>Linguistic Analysis</td>
<td></td>
</tr>
</tbody>
</table>

Project (choose 1)

A semester-long directed research project OR paper to provide hands-on experience and an in-depth study of a topic (in same area as a chosen elective)

Example Course Sequence

The core gives a general introduction to language technologies, with an emphasis on natural language processing (NLP). The electives and project give in-depth experience in one or two specific language technologies. Though students would be able to mix and match as they see fit, one possible sequence is:

<table>
<thead>
<tr>
<th>Junior</th>
<th>Spring</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Elective - if F</td>
<td>Fall</td>
</tr>
<tr>
<td>elective</td>
<td>Elective (s) - if S elective(s)</td>
<td>11-721 Grammars &amp; Lexicons Project and Lexicons</td>
</tr>
</tbody>
</table>
or other minors. However, courses taken for general education requirements of the student’s degree are not considered to be double counted. A course taken to satisfy one core area cannot be used to satisfy the course requirement for another core area. The following listing presents a set of current possible courses in each area. Other computational neuroscience courses are being developed at Carnegie Mellon and University of Pittsburgh that will also satisfy core area A requirement and the requirements will be updated as they come on-line. Substitution is possible but requires approval.

A. Neural Computation

- 15-386 Neural Computation 9
- 15-883 Computational Models of Neural Systems 12
- 85-419 Introduction to Parallel Distributed Processing
- Pitt-Mathematics-1800 Introduction to Mathematical Neuroscience 9

B. Neuroscience

- 03-362 Cellular Neuroscience 9
- 03-363 Systems Neuroscience 9
- 03-761 Neural Plasticity 9
- 85-765 Cognitive Neuroscience 9
- Pitt-Neuroscience 1000 Introduction to Neuroscience 9
- Pitt-Neuroscience 1012 Neurophysiology 9

C. Cognitive Psychology

- 85-211 Cognitive Psychology 9
- 85-213 Human Information Processing and Artificial Intelligence 9
- 85-412 Cognitive Modeling 9
- 85-419 Introduction to Parallel Distributed Processing 9
- 85-429 Neural Basis of Cognitive-Development 9
- 85-765 Cognitive Neuroscience 9

D. Intelligent System Analysis

- 10-601 Machine Learning 12
- 10-381 Artificial Intelligence: Representation and Problem Solving 9
- 15-385 Computer Vision 9
- 15-386 Neural Computation 9
- 15-486 Artificial Neural Networks 12
- 15-494 Special-Topics-Cognitive Robotics 12
- 16-299 Introduction to Feedback Control Systems 12
- 16-311 Introduction to Robotics 12
- 24-352 Dynamic Systems and Controls 12
- 36-225 Introduction to Probability Theory 9
- 36-247 Statistics for Lab Sciences 9
- 36-401 Modern Regression 9
- 36-410 Introduction to Probability Modeling 9

Prerequisites

The required courses in the above four core areas require a number of basic prerequisites: basic programming skills at the level of , and basic mathematical skills at the level of 21-122 Integration, Differential Equations and Approximation or their equivalents. Some courses in Area D require additional prerequisites. Area B Biology courses require, at minimum, 03-121 Modern Biology. Students might skip the prerequisites if they have the permission of the instructor to take the required courses. Prerequisite courses are typically taken to satisfy the students’ major or other requirements. In the event that these basic skill courses are not part of the prerequisite or required courses of a student’s major, one of them can potentially count toward the five required courses (e.g. the depth elective), conditioned on approval.

Research Requirements (Optional)

The minor itself does not require a research project. The student however may replace the depth elective with a year-long research project. In special circumstances, a research project can also be used to replace one of the courses, as long as (1) the project is not required by the student’s major or other minor, (2) the student has taken a course in each of the four core areas (not necessarily for the purpose of satisfying this minor’s requirements), and (3) has taken at least three courses in this curriculum not counted toward the student’s major or other minors. Students interested in participating in the research project should contact any faculty engaged in computational neuroscience research at Carnegie Mellon or in the University of Pittsburgh. A useful webpage that provides listing of faculty in neural computation and computational neuroscience is http://www.cnbc.cmu.edu/cnbc-directory/. The director of the minor program will be happy to discuss with students about their research interest and direct them to the appropriate faculty.

Fellowship Opportunities

The Program in Neural Computation (PNC) administered by the Center for the Neural Basis of Cognition currently provides 3-4 competitive full-year fellowship ($11,000) to Carnegie Mellon undergraduate students to carry out mentored research in neural computation. The fellowship has course requirements similar to the requirements of the minor. Students do not apply to the fellowship program directly. They have to be nominated by the faculty members who are willing to mentor them. Therefore, students interested in the full-year fellowship program should contact and discuss research opportunities with any CNBC faculty at Carnegie Mellon or University of Pittsburgh working in the area of neural computation or computational neuroscience and ask for their nomination by sending email to Dr. Tai Sing Lee, who also administers the undergraduate fellowship program at Carnegie Mellon. See http://www.cnbc.cmu.edu/fellowcompneuro for details.

The Program in Neural Computation also offers a summer training program for undergraduate students from any U.S. undergraduate college. The students will engage in a 10-week intense mentored research and attend a series of lectures in neural computation. See the http://www.cnbc.cmu.edu/ summercompneuro for application information.

Robotics Additional Major

Howie Choset, Director
Office: NSH 3205
Website: http://www.ri.cmu.edu/

Beginning in Fall 2012, the School of Computer Science will be offering Robotics as an additional major, available to all Carnegie Mellon undergraduate students.

The robotics major’s central intellectual theme is that robotics is both multidisciplinary and interdisciplinary. This means that it draws from many fields, such as mechanical engineering, computer science and electrical engineering, and it also integrates these fields in a novel manner. The base of this program lies in motion and control. Upon this base, sensing, cognition, and action are layered. These foci are brought together by a unique systems perspective special to robotics. Finally, robotics involves building artifacts that embody these Fundamentals, foci, and systems thinking, and as such there is a “hands-on” requirement as well.

Admission

Generally, students should apply in their sophomore year but we could allow admissions for students in their junior year provided they meet the requirements and their schedule would allow. The deadline should be early December and decisions should be made in time for Spring registration in the sophomore year. The materials include:

- Full name, student number, and email address
- Home college, year you intend to graduate, and list of all declared Majors and Minors
- Statement of purpose (maximum 1 page, single spaced, to articulate why the student wants to pursue the robotics major)
- Proposed schedule of required courses (we will provide a table for them to fill out)
- Transcript

Carnegie Mellon University
gain this knowledge by taking 15-122 Principles of Imperative Computation (units).

**Required Courses**

**Overview:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-311</td>
<td>Introduction to Robotics</td>
<td>12</td>
</tr>
</tbody>
</table>

**Controls** (choose one of the following):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-451</td>
<td>Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-370</td>
<td>Fundamentals of Control</td>
<td>12</td>
</tr>
<tr>
<td>16-399</td>
<td>Introduction to Feedback Control Systems (Computer Science)</td>
<td>12</td>
</tr>
</tbody>
</table>

**Manipulation** (choose one of the following):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-384</td>
<td>Robot Kinematics and Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>24-355</td>
<td>Kinematics and Dynamics of Mechanisms</td>
<td>9</td>
</tr>
</tbody>
</table>

**Electives**

Two Electives (chosen from the following):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-601</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>11-344</td>
<td>Machine Learning in Practice</td>
<td>12</td>
</tr>
<tr>
<td>15-381</td>
<td>Artificial Intelligence: Representation and Problem Solving</td>
<td>9</td>
</tr>
<tr>
<td>15-385</td>
<td>Computer Vision</td>
<td>9</td>
</tr>
<tr>
<td>15-462</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>15-491</td>
<td>Special Topic: CMRoboBits: Creating Intelligent Robots</td>
<td>12</td>
</tr>
<tr>
<td>15-494</td>
<td>Special Topic: Cognitive Robotics</td>
<td>12</td>
</tr>
<tr>
<td>16-264</td>
<td>Humansoids</td>
<td>12</td>
</tr>
<tr>
<td>16-362</td>
<td>Mobile Robot Programming Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>16-421</td>
<td>Vision Sensors</td>
<td>12</td>
</tr>
<tr>
<td>18-342</td>
<td>Fundamentals of Embedded Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-348</td>
<td>Embedded Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-349</td>
<td>Embedded Real-Time Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-549</td>
<td>Embedded Systems Design</td>
<td>12</td>
</tr>
<tr>
<td>18-578</td>
<td>Mechatronic Design</td>
<td>12</td>
</tr>
<tr>
<td>24-491</td>
<td>Department Research Honors</td>
<td>-1</td>
</tr>
<tr>
<td>24-675</td>
<td>MicroNano Robotics</td>
<td>12</td>
</tr>
<tr>
<td>39-500</td>
<td>Honors Research Project</td>
<td>-1</td>
</tr>
<tr>
<td>85-370</td>
<td>Perception</td>
<td>9</td>
</tr>
<tr>
<td>85-382</td>
<td>Consciousness and Cognition</td>
<td>9</td>
</tr>
<tr>
<td>85-395</td>
<td>Applications of Cognitive Science</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-419</td>
<td>Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
</tbody>
</table>

**Double-Counting Restriction**

Courses in the Robotics Minor may not be counted towards another SCS minor.

**Software Engineering Minor**

**Director:** Jonathan Aldrich  
**Website:** http://isri.cmu.edu/education/undergrad/

The Software Engineering minor is designed to teach the fundamental tools, techniques, and processes of software engineering. Through internships and a mentored project experience, students gain an understanding of the issues of scale and complexity that motivate software engineering tools and techniques. The core curriculum includes material both on engineering the software product and on the process, teamwork, and management skills that are essential to successful engineering. Graduates of the program should have the technical, process, and teamwork skills to be immediately productive in a mature engineering organization.

**Prerequisite**

**Core Course Requirements**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
</table>

**Electives**

The minor requires three elective courses, one selected from each of the following categories:

1. One domain-independent course focused on technical software engineering material:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-414</td>
<td>Bug Catching: Automated Program Verification and Testing</td>
<td>9</td>
</tr>
<tr>
<td>17-651</td>
<td>Models of Software Systems</td>
<td>12</td>
</tr>
<tr>
<td>17-652</td>
<td>Methods: Deciding What to Design</td>
<td>12</td>
</tr>
<tr>
<td>17-653</td>
<td>Managing Software Development</td>
<td>12</td>
</tr>
<tr>
<td>17-654</td>
<td>Analysis of Software Artifacts</td>
<td>12</td>
</tr>
<tr>
<td>17-655</td>
<td>Architectures for Software Systems</td>
<td>12</td>
</tr>
</tbody>
</table>
2. One engineering-focused course with a significant software component:

- 15-410 Operating System Design and Implementation 12
- 15-412 Operating System Practicum 12
- 15-437 Web Application Development 12
- 15-440 Distributed Systems 12
- 15-441 Computer Networks 12
- 15-610 Engineering Distributed Systems 12
- 18-549 Embedded System Design 12
- 28-649 Distributed Embedded Systems 12

Other courses, with prior approval from the Director of the Software Engineering Masters Program

3. One course that explores computer science problems related to existing and emerging technologies and their associated social, political, legal, business, and organizational contexts:

- 08-200 Ethics and Policy Issues in Computing 9
- 08-533 Privacy, Policy, Law and Technology 9
- 08-801 Dynamic Network Analysis 12
- 15-390 Entrepreneurship for Computer Science 9
- 19-402 Telecommunications, Technology Policy & Management 12
- 19-403 Policies of Wireless Systems and the Internet 12
- 70-311 Organizational Behavior 9
- 70-414 Technology Based Entrepreneurship for CIT 9
- 70-421 Entrepreneurship for Computer Scientists 9
- 70-471 Logistics and Supply Chain Management 9
- 88-260 Organizations 9
- 88-341 Organizational Communication 9
- 88-343 Economics of Technological Change 9

Required Internship and Reflection Course

A software engineering internship of a minimum of 8 full-time weeks in an industrial setting is required. The student must be integrated into a team and exposed to industry pressures. The intern may work in development, management, quality assurance, or other relevant positions. The director of the SE minor program has sole discretion in approving an internship experience based on these criteria. Students should confirm that an internship position is appropriate before accepting it, but internships that fulfill the criteria will also be accepted after the fact.

Double Counting Rule

At most 2 of the courses used to fulfill the minor requirements may be counted towards any other major or minor program.

SCS Policies & Procedures

School of Computer Science (SCS) Academic Standards and Actions

Grading Practices

Grades given to record academic performance in SCS are detailed under Grading Practices at http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations/

Dean’s List

SCS recognizes each semester those undergraduates who have earned outstanding academic records by naming them to the Dean’s List. The criteria for such recognition is a quality point average of at least 3.75 while completing a minimum of 36 factorable units and earning no incomplete grades.

Academic Actions

In the first year, quality point averages below 1.75 in either semester invoke an academic action. For all subsequent semesters an academic action will be taken if the semester quality point average or the cumulative quality point average (excluding the first year) is below 2.00.

Probation: The action of probation will be taken in the following cases:

1. One semester of the first year is below 1.75 QPA;
2. The semester QPA of a student in good standing beyond the first year falls below 2.00.

The term of probation is one semester as a full-time student. First year students are no longer on probation at the end of the second semester if the second semester’s QPA is 1.75 or above. Students in the third or subsequent semester of study are no longer on probation at the end of one semester if the semester QPA and cumulative QPA (excluding the first year) are 2.00 or above.

Probation Continued: A student who has had one semester on probation and is not meeting minimum requirements but whose record indicates that the standards are likely to be met at the end of the next semester of study is occasionally continued on probation. This action is normally taken only when a student’s semester QPA is above 2.0 but their cumulative QPA is not yet above 2.0.

Suspension: A student who does not meet minimum standards at the end of one semester of probation will be suspended:

- A first year student will be suspended if the QPA from each semester is below 1.75.
- A student on probation in the third or subsequent semester of study will be suspended if the semester QPA is below 2.00.

The minimum period of suspension is one academic year (two semesters). At the end of that period a student may return to school (on probation) by:

1. receiving permission in writing from the Associate Dean for Undergraduate Education, or the student’s academic advisor,
2. completing a Return from Leave form from the HUB

Students who have been suspended or have withdrawn are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes debarment from part-time or summer courses at the university for the duration of the period of the action. Although suspended students may not hold student jobs, students on academic suspension may, under certain circumstances, have a non-student job with the university. Students on disciplinary or administrative suspension may not.

Drop: This is a permanent severance. A student who has been suspended and who fails to meet minimum standards in the semester that they return to school will be dropped.

Students who have been dropped are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action.

The relation indicated above between probation, suspension and drop is nominal. In unusual circumstances, College Council may suspend or drop a student without prior probation.

Transfer into SCS

Undergraduate students admitted to colleges at CMU other than SCS and wishing to transfer into SCS during their first year should consult with the Assistant Dean for Undergraduate Education. In general, no undergraduate student will be considered for transfer until after having completed a 200-level Computer Science course. At that time, the decision to allow transfer will be made based on availability of space in the student’s class and the student’s academic performance.

Procedure for transfer of students from another university into SCS: A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student’s record is sent to SCS for evaluation. Extremely few external transfers are admitted.

Graduation Requirements

1. A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of 2.00 or higher for all courses taken after the first year.
2. Students must be recommended for a degree by the faculty of SCS.
3. A candidate for the bachelor’s degree must complete at the University a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of coursework.
4. Students will be required to have met all financial obligations to the university before being awarded a degree.

Modification of Graduation Requirements: A student may seek permission to modify graduation requirements by petition to the SCS College Council.

Research and Teaching Faculty

UMUT ACAR, Assistant Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005-.
VICTOR ADAMCHIK, Associate Teaching Professor – Ph.D., Byelorussian State University; Carnegie Mellon, 2000–.

JONATHAN ALDRICH, Associate Professor – Ph.D., University Of Washington; Carnegie Mellon, 2003–.

VINCENT ALEVEN, Associate Professor – Ph.D., University Of Pittsburgh; Carnegie Mellon, 1997–.

OMEAD AMIDI, Senior Systems Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994–.

DAVID ANDERSEN, Associate Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2005–.

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GUY BLELOCH, Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1988–.

AVRIM BLUM, Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1991–.

LENORE BLUM, Distinguished Career Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1999–.

MANUEL BLUM, Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1999–.

DAVID BOURNE, Principal Systems Scientist – M.S., University Of Pennsylvania; Carnegie Mellon, 1980–.

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JAMES CALLAN, Professor – Ph.D., University Of Massachusetts; Carnegie Mellon, 1999–.

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KATHLEEN CARLEY, Professor – Ph.D., Harvard University; Carnegie Mellon, 2002–.

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SRINIVASA NARASIMHAN, Associate Professor – Ph.D., Columbia University; Carnegie Mellon, 2004–.

CHRISTINE NEUWIRTH, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–.

ILLAH NOURBakhsh, Professor – Ph.D., Stanford University; Carnegie Mellon, 1997–.

ERIC NYBERG, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989–.

RYAN O'DONNELL, – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2006–.

DAVID O'HALLARON, Associate Professor – Ph.D., University of Virginia; Carnegie Mellon, 1986–.

IRVING OPPENHEIM, Professor – Ph.D., Cambridge University; Carnegie Mellon, 1973–.

MARK PAULK, Senior Systems Scientist – Ph.D., University of Pittsburgh; Carnegie Mellon, 1987–.

ERIC PAULOS, Associate Professor – Ph.D., University Of California At Berkeley; Carnegie Mellon, 2008–.

PHILIP PAVLIK, Systems Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008–.

FRANK PFENNING, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986–.

ANDRE PLATZER, Assistant Professor – Ph.D., University of Oldenburg; Carnegie Mellon, 2008–.

BARNABAS POczOS, Assistant Professor – Ph.D., Eötvös Loránd University; Carnegie Mellon, 2004–.

NANCY POLLARD, Associate Professor – Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2002–.

ARIEL PROCACCIA, Assistant Professor – Ph.D., The Hebrew University of Jerusalem; Carnegie Mellon, 2008–.

BHIKSHA RAJ RAMAKRISHNAN, Associate Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008–.

RAJ REDDY, Herbert A Simon University Professor – Ph.D., Stanford University; Carnegie Mellon, 1969–.

MARGARET REID-MILLER, Assistant Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002–.

JOHN REYNOLDS, Professor – Ph.D., Harvard University; Carnegie Mellon, 1986–.

CAMERON RIVIERE, Associate Research Professor – Ph.D., Johns Hopkins; Carnegie Mellon, 1995–.

ALFRED RIZZI, Associate Research Professor – Ph.D., Yale University; Carnegie Mellon, 1998–.

DAVID ROOT, Associate Teaching Professor – M.P.M., Carnegie Mellon University; Carnegie Mellon, 2004–.

CAROLYN ROSE, Associate Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003–.

RONALD ROSENFELD, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995–.

ZACK RUBINSTEIN, Systems Scientist – Ph.D., University of Massachusetts; Carnegie Mellon, 2005–.

STEVEN RUDICH, Professor – Ph.D., University of California; Carnegie Mellon, 1989–.

ALEXANDER RUDNICKY, Research Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1980–.

PAUL RYBSKI, Senior Systems Scientist – Ph.D., University of Minnesota; Carnegie Mellon, 2003–.

NORMAN SADEH-KONIECPOL, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991–.

TUOMAS SANDHOLM, Professor – Ph.D., University of Massachusetts; Carnegie Mellon, 2001–.

MAHADEV SATYANARAYANAN, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–.

PAUL SCERRI, Associate Research Professor – Ph.D., Linkoping University; Carnegie Mellon, 2003–.

RICHARD SCHEINES, Professor and Department Head, Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1988–.

WILLIAM SCHERLIS, Professor and Director, Institute for Software Research – Ph.D., Stanford University; Carnegie Mellon, 1989–.

BRADLEY SCHMERL, Senior Systems Scientist – Ph.D., Flinders University of South Australia; Carnegie Mellon, 2000–.

JEFF SCHNEIDER, Associate Research Professor – Ph.D., University of Rochester; Carnegie Mellon, 1995–.

TANJA SCHULTZ, Assistant Research Professor – Ph.D., University of Karlsruhe; Carnegie Mellon, 2001–.

SCOTT MILLER, Professor – Ph.D., University Of California; Carnegie Mellon, 1972–.

DANA SCOTT, University Professor Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1981–.

TEDDY SEIDENFELD, Herbert A Simon Professor – Ph.D., Columbia University; Carnegie Mellon, 1985–.

SRINIVASAN SESHAN, Professor – Ph.D., University of California; Carnegie Mellon, 2000–.

MICHAEL SHAMOS, Principal Systems Scientist – Ph.D., Yale University; Carnegie Mellon, 1975–.

MARY SHAW, Alan Perlis Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1965–.

MEL SIEGEL, Associate Research Professor – Ph.D., University of Colorado; Carnegie Mellon, 1982–.

BRUCE MCLAREN, Senior Systems Scientist – Ph.D., University Of Pittsburgh; Carnegie Mellon, 1984–.

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CAMERON RIVIERE, Associate Research Professor – Ph.D., Johns Hopkins; Carnegie Mellon, 1995–.

ALFRED RIZZI, Associate Research Professor – Ph.D., Yale University; Carnegie Mellon, 1998–.

DAVID ROOT, Associate Teaching Professor – M.P.M., Carnegie Mellon University; Carnegie Mellon, 2004–.

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RONALD ROSENFELD, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995–.

ZACK RUBINSTEIN, Systems Scientist – Ph.D., University of Massachusetts; Carnegie Mellon, 2005–.

STEVEN RUDICH, Professor – Ph.D., University of California; Carnegie Mellon, 1989–.

ALEXANDER RUDNICKY, Research Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1980–.

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NORMAN SADEH-KONIECPOL, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991–.

TUOMAS SANDHOLM, Professor – Ph.D., University of Massachusetts; Carnegie Mellon, 2001–.

MAHADEV SATYANARAYANAN, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–.

PAUL SCERRI, Associate Research Professor – Ph.D., Linkoping University; Carnegie Mellon, 2003–.

RICHARD SCHEINES, Professor and Department Head, Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1988–.

WILLIAM SCHERLIS, Professor and Director, Institute for Software Research – Ph.D., Stanford University; Carnegie Mellon, 1989–.

BRADLEY SCHMERL, Senior Systems Scientist – Ph.D., Flinders University of South Australia; Carnegie Mellon, 2000–.

JEFF SCHNEIDER, Associate Research Professor – Ph.D., University of Rochester; Carnegie Mellon, 1995–.

TANJA SCHULTZ, Assistant Research Professor – Ph.D., University of Karlsruhe; Carnegie Mellon, 2001–.

SCOTT MILLER, Professor – Ph.D., University Of California; Carnegie Mellon, 1972–.

DANA SCOTT, University Professor Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1981–.

TEDDY SEIDENFELD, Herbert A Simon Professor – Ph.D., Columbia University; Carnegie Mellon, 1985–.

SRINIVASAN SESHAN, Professor – Ph.D., University of California; Carnegie Mellon, 2000–.

MICHAEL SHAMOS, Principal Systems Scientist – Ph.D., Yale University; Carnegie Mellon, 1975–.

MARY SHAW, Alan Perlis Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1965–.

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RITA SINGH, Systems Scientist.
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DANIEL SLEATOR, Professor – Ph.D., Stanford University; Carnegie Mellon, 1985–.
NOAH SMITH, Associate Professor – Ph.D., Johns Hopkins University; Carnegie Mellon, 2006–.
STEPHEN SMITH, Research Professor – Ph.D., University of Pittsburgh; Carnegie Mellon, 1982–.
ALEX SMOLA, Professor – Ph.D., Technische Universität Berlin; Carnegie Mellon, 1998–.
PETER SPIRTES, Professor and Associate Head, Philosophy – Ph.D., University of Pittsburgh; Carnegie Mellon, 1983–.
SIDDHARTHA SRINIVASA, Assistant Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–.
JOHN STAMPER, Systems Scientist – Ph.D., University of North Carolina At Charlotte; Carnegie Mellon, 2010–.
PETER STEENKISTE, Professor – Ph.D., Stanford University; Carnegie Mellon, 1987–.
MARK STEHLIK, Teaching Professor – B.S., Pace University; Carnegie Mellon, 1981–.
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ANTHONY STENTZ, Research Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989–.
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SCOTT STEVENS, Senior Systems Scientist – Ph.D., University of Nebraska; Carnegie Mellon, 1987–.
KLAUS SUTNER, Teaching Professor, Associate Dean for Undergraduate Education – Ph.D., University of Munich; Carnegie Mellon, 1995–.
LATANYA SWEENEY, Distinguished Career Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1998–.
KATIA SYCARA, Research Professor – Ph.D., Georgia Institute of Technology; Carnegie Mellon, 1987–.
GIL TARAN, Associate Teaching Professor – M.S.I.T., Carnegie Mellon University; Carnegie Mellon, 2002–.
SUJATA TELANG, Associate Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004–.
KAREN THICKMAN, Assistant Teaching Professor – Ph.D., Johns Hopkins University; Carnegie Mellon, 2006–.
CHARLES THORPE, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984–.
DAVID TOLLIVER, Systems Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008–.
ANTHONY TOMASIC, Senior Systems Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008–.
DAVID TOURETZKY, Research Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003–.
ADRIEN TREUILLE, Assistant Professor – Ph.D., University Of Washington; Carnegie Mellon, 2008–.
CHRISTOPHER URMSON, Assistant Research Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–.
MANUELA VELOSO, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992–.
LUIS VON AHN, Associate Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–.
STEPHAN VOGEL, Assistant Research Professor – M.Phil., University of Cambridge; .
HOWARD WACHTLAR, Alumni Research Professor of Computer Science – M.S., University of Maryland; Carnegie Mellon, 1967–.
ALEXANDER WAIBEL, Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989–.
Robert M. Dammon, Dean
Michael A. Trick, Senior Associate Dean, Education
Undergraduate Program Offices: Tepper 139
http://www.tepper.cmu.edu

The mission of the Tepper School of Business is to improve the leadership and problem-solving capabilities of individuals so as to enhance their value to organizations and society at large. The Tepper School of Business strives for excellence in the creation and dissemination of knowledge that is grounded in scientific principles and interdisciplinary collaboration, and is directed toward improving the practice and profession of management.

History
Since its founding in 1949 by William Larrimer Mellon, the Tepper School of Business at Carnegie Mellon has been a pioneer in the field of analytical decision-making and management science. Its three main activities are undergraduate education, graduate education, and research.

Today, the business school is most recognized for research and teaching in the areas of organizational behavior, finance, economics, operations management, computational marketing and operations research. The School’s notable contributions to the intellectual community include eight Nobel laureates. It is also ranked among the schools with the highest rate of academic citations in the fields of finance, operations research, organizational behavior and operations/production. The academic offerings of the Tepper School of Business include undergraduate studies in business and economics, masters studies in business administration and financial engineering, and doctoral studies.

Undergraduate and graduate students gain a valuable academic foundation in the fundamental disciplines of economics, the behavioral sciences and the management sciences. In addition to emphasizing an analytical approach to problem-solving and decision-making, students integrate communication, strategic thinking and leadership into their student experience.

Educational Objectives
The Tepper School of Business is home to the Undergraduate Business Administration and Undergraduate Economics Program (joint with the Mariana Brown Dietrich College of Humanities and Social Sciences). The Tepper School of Business at Carnegie Mellon endeavors to be the world leader and path-breaker in management education and research, known internationally for:

• Graduates who are capable of being high-impact business leaders, who are entrepreneurial and continue to learn, and who can harness information and technology to produce sustainable economic growth.

• Education and research programs that are innovative, interdisciplinary, information-technology intensive and international in scope, and that seamlessly build upon the core competencies of the Tepper School of Business and Carnegie Mellon University, thereby maximizing impact and value.

• A learning environment that capitalizes on the advantage of diversity of community, the open exchange of ideas, and where discovery, innovation and creativity flourish.

• Values that build upon high expectations of ethical behavior, respect for the individual, responsibility to society, dedication to work, and commitment to quality and continuous improvement.

Academic Programs
Undergraduate Degrees Offered
Each department in the Tepper School offers degrees and programs that allow students to explore particular fields within their major. These are outlined below — see the departmental sections of the catalog for further details.

Undergraduate Business Administration
The Tepper School offers a B.S. degree in Business Administration with tracks in the following areas:

• Computing and Information Technology
• Entrepreneurship

• Finance
• General Management
• Graphic Media Management
• International Management
• Manufacturing Management and Consulting
• Marketing

Undergraduate Economics Program
The Undergraduate Economics Program has a unique position at Carnegie Mellon University. It is the sole undergraduate program that is a joint program of the Tepper School of Business and the Dietrich College of Humanities and Social Sciences. The combination of research strength (Tepper has been home to eight Nobel Laureates in Economics) and commitment to liberal arts and interdisciplinary studies (Dietrich has “the most creative general education program of any American university” – New York Times) provides our undergraduates with a world-class economics program.

Economics majors are considered members of both colleges and enjoy their full support and services of both. Undergraduate economics students should consult the program’s website and handbook for details about applicable Tepper and Dietrich academic policies and procedures.

The Undergraduate Economics Program has four named degrees (listed below). These degree programs couple prerequisites with the opportunity to tailor elective choices to enable students to develop depth in topics of particular interest to them. Potential topics include economics and policy, economics of financial markets, economics in the global market place, game theory, market design and strategy, macroeconomics (applied and/or theory), microeconomics (applied and/or theory).

• B.A. or B.S. in Economics
• B.S. in Economics and Mathematical Sciences
• B.S. in Economics and Statistics
• Minor in Innovation, Economics, and Entrepreneurship

Minors, Additional Majors and Dual Degrees
Both undergraduate programs offer additional majors, dual degrees and minors to all members of the CMU undergraduate community. Acceptance into these degree programs is at the discretion of the individual undergraduate program offices.

Tepper School undergraduate students may pursue additional majors and minors to complement their primary degree; these degrees are administered not only within the business school, but also through the other colleges at Carnegie Mellon. Every college and most departments have designed minors or second majors in their discipline; additionally, many interdisciplinary majors and minors have been created. For more information, consult the “Degrees Offered (https://coursecatalog-new.web.cmu.edu/degreesoffered)” list.

First Year Experience and General Education Program
Although the undergraduate business students and the undergraduate economics students follow different first year curricula, both programs provide a broad foundation upon which students build their eventual majors. Details about the first-year experience and general education requirements for the undergraduate business students and the undergraduate economics students can be found, respectively, on the Undergraduate Business Program website (http://tepper.cmu.edu/undergraduate-business/academics) and the Dietrich College of Humanities and Social Sciences General Education website (http://www.hss.cmu.edu/gened).

Study Abroad
The Undergraduate Programs encourage students to consider enriching their educational experience by studying abroad during their undergraduate tenure. Interested students should meet with their academic advisors and with the Office of International Educational advisors.

Honors Degree Programs
Both the Undergraduate Economics Program and the Undergraduate Business Administration Program encourage and offer qualified students the opportunity to participate in an honors degree program. See each program’s section of the catalog for more details.
Accelerated Masters Programs

All Carnegie Mellon undergraduates with outstanding academic performance are eligible to apply to the Tepper School of Business accelerated MBA program. Students are accepted to bypass their senior year as undergraduates and earn both their bachelor's degree and their MBA degree in five years. Applicants to the 3-2 program are evaluated not only on their academic achievement but also on their maturity, commitment, sense of direction, and interpersonal and communications skills. Their experiences in summer internships and their extracurricular activities are also evaluated. Admission to the MBA program is highly competitive, and 3-2 applicants compete with the entire applicant pool for spaces in the program. Students interested in the 3-2 program should read the MBA catalog, available from the Masters Admissions Office. They should also talk with their individual academic advisors concerning completion of their undergraduate requirements.

Tepper School undergraduate students are also eligible to apply to the accelerated masters programs (Masters of Arts Management, Masters in Biotechnology Management, Masters of Health Care Policy and Management, Masters of Public Policy and Management, and Masters of Information Systems) offered by the H. J. Heinz III College.

Research Centers

Website: http://tepper.cmu.edu/faculty-research/research-centers/index.aspx

True to its heritage, the Tepper School commits significant resources to continuing research that advances business practice and theory. Students have the opportunity to learn from professors who spearhead internationally recognized research centers, including:

- Accelerate Leadership Center (http://coursecatalog.web.cmu.edu/tepper/
  %20www.tepper.cmu.edu/accelerate)
- Carnegie Bosch Institute for Applied Studies in International Management (http://cbi.tepper.cmu.edu)
- Carnegie Mellon Electricity Industry Center (http://wpweb2.tepper.cmu.edu/ceic)
- Center for Behavioral Decision Research (http://www.cbrd.cmu.edu)
- Center for International Corporate Responsibility (http://www.cibtepper.cmu.edu/cicr)
- Center for the Management of Technology (http://wpweb2.tepper.cmu.edu/cicr)
- Center for Marketing Technology and Information (http://tepper.cmu.edu/ faculy-research/research-centers/center-for-marketing-technologies-and-
  information)
- Center for Organizational Learning, Innovation and Knowledge (http://
  wpweb2.tepper.cmu.edu/orgsci/CLIK_2011.htm)
- Donald H. Jones Center for Entrepreneurship (http://tepper.cmu.edu/
  faculty-research/research-centers/donald-h-jones-center-for-
  entrepreneurship)
- Green Design Institute (http://www.ce.cmu.edu/GreenDesign)

Tepper School Policies and Procedures

Academic Standards

A detailed list and explanation of university-wide academic standards and practices governing undergraduate students may be found in the "Undergraduate Academic Regulations" (http://coursecatalog.web.cmu.edu/ servicesandoptions/undergraduateacademicregulations) section of the catalog. Below you will find rules that apply specifically to the Tepper School undergraduate student.

Dean's Lists

Undergraduate Business Administration Program

Each semester, the Tepper School Dean's Office recognizes undergraduate Business Administration students who have earned outstanding academic records by naming them to the Dean's List. Students in the Economics Programs are also recognized for their outstanding records by the Dean's Office of the Dietrich College of Humanities and Social Sciences.

The criteria for earning Dean's List recognition in the undergraduate Business Administration Program are: a semester QPA of at least 3.50 while completing at least 45 factorable units of coursework and earning no conditional grades (I, X) at the time that final grades are recorded; a semester QPA of at least 3.75 while completing between 36 and 44 factorable units of coursework and earning no conditional grades (I, X) at the time that final grades are recorded; a semester QPA of at least 3.75 while completing at least 45 factorable units of coursework and earning no conditional grades (I, X) at the time that final grades are recorded, which will earn students Dean's List with Honors.

Academic Actions

Undergraduate Business Administration Program

Probation: a student earning less than a 2.00 QPA in any semester is subject to academic action and is placed on academic probation. The term of probation is one semester as a full-time student.

Students generally are removed from probation and restored to good standing after earning a semester QPA of 2.00 or better and when their cumulative QPA is 2.00 or above. Students on probation who meet this QPA criterion, but carry less than the average number of course units in a semester, may be subject to continued probation status at the Program's discretion.

Suspension: a student who does not meet minimum standards at the end of one semester of probation will be suspended. The minimum period of suspension is one academic year (two semesters). At the end of that period a student may return to school (on probation) by:

1. receiving permission in writing from the Program Director, and
2. completing a Return from Leave form (found on The HUB's website)

Students who have been suspended or have withdrawn are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes debarment from part-time or summer courses at the university for the duration of the period of the action. Although suspended students may not hold student jobs, students on academic suspension may, under certain circumstances, have a non-student job with the university. Students on disciplinary or administrative suspension may not.

Drop: This is a permanent severance. A student who has been suspended and who fails to meet minimum standards in the semester that they return to school will be dropped.

Students who have been dropped are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action.

Undergraduate Economics Program

Undergraduate Economics students are governed by the Dietrich College academic actions policies (https://coursecatalog.
new.web.cmu.edu/dietrichcollegeofhumanitiesandsocialsciences/
#academicstandardsregulationsandprotocols).

Graduation Requirements

Students in both the undergraduate Business Administration and Economics Programs qualify to graduate by meeting the following conditions:

1. Complete all degree, College, and University course requirements as shown in the Undergraduate Business Administration's and Undergraduate Economics Programs sections of this catalog.
2. Be recommended for their degree by the faculty of the Tepper School.
3. Meet the University's residency requirement, detailed in the "Undergraduate Academic Regulations" (http://
  coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations) section of the catalog.
4. Meet all financial obligations to the university before being awarded a degree.

Modification of Graduation Requirements: A student may seek permission to modify graduation requirements by petition to the Program head and the Senior Associate Dean, Education.

Transfer into Tepper School of Business

Undergraduate students admitted to colleges at CMU other than the Tepper School and wishing to transfer into Tepper during should consult with their current academic advisor and with an academic advisor in their program of
The decision to allow transfer will be made based on availability of space in the student's class and the student's academic performance. Transfer into Tepper School of Business is determined at the program level. Students wishing to transfer into the Undergraduate Business Administration Program should follow the instructions provided on the Transfer Information website (http://tepper.cmu.edu/undergraduate-business/academic-information/transfer-information). Students wishing to transfer into the Undergraduate Economics Program should follow the instructions provided on the Program's Academic Information website (http://tepper.cmu.edu/current-students/current-economics-undergraduates/academic-information/declaring-a-major-dual-degree-addl-major-or-minor).

The Undergraduate Business Administration Program does not accept transfer students from other universities.

**Full-Time Faculty**

MUSTAFA AKAN, Assistant Professor of Operations Management – Ph.D., Northwestern University; Carnegie Mellon, 2008–.
LAURENCE ALES, Assistant Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2008–.
KATHARINE ANDERSON, Assistant Professor of Economics and Entrepreneurship – Ph.D., University of Michigan; Carnegie Mellon, 2010–.
JAY APT, Professor of Technology; Director, Carnegie Mellon Electricity Industry Center – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000–.
LINDA ARGOTE, David M. Kirr and Barbara A. Kirr Professor of Organizational Behavior and Theory; Director, Center for Organizational Learning, Innovation and Performance – Ph.D., University of Michigan; Carnegie Mellon, 1979–.
BRANDY L. AVEN, Assistant Professor of Organizational Behavior and Theory – Ph.D., Stanford University; Carnegie Mellon, 2010–.
EGON BALAS, University Professor of Industrial Administration and Applied Mathematics; Thomas Lord Professor of Operations Research – D.Sc.Ec., University of Brussels; D.U. (Math), University of Paris; Carnegie Mellon, 1968–.
ILKER BAYBARS, Deputy Dean Emeritus; George Leland Bach Chair; Professor of Operations Management – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1979–.
ANTJE BERNDT, Assistant Professor of Finance – Ph.D., Stanford University; Carnegie Mellon, 2005–.
BAHAR BILLER, Associate Professor of Operations Management – Ph.D., Northwestern University; Carnegie Mellon, 2002–.
PETER BOATWRIGHT, Associate Professor of Marketing – Ph.D., University of Chicago; Carnegie Mellon, 1997–.
ARTHUR A. BONI, The John R. Thorne Distinguished Career Professor of Entrepreneurship – Ph.D., University of California, San Diego; Carnegie Mellon, 2001–.
STEPHEN M. CALABRESE, Visiting Associate Professor of Economics, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.
SOO-HAENG CHO, Assistant Professor of Operations Management – Ph.D., University of California, Los Angeles (UCLA); Carnegie Mellon, 2008–.
ROSALIND M. CHOW, Assistant Professor of Organizational Behavior and Theory – Ph.D., Stanford University; Carnegie Mellon, 2008–.
MILTON L. COFIELD, Executive Director, B.S. Administration Program; Teaching Professor of Business Management – Ph.D., University of Illinois; Carnegie Mellon, 2001–.
TAYA R. COHEN, Assistant Professor of Organizational Behavior and Theory – Ph.D., University North Carolina, Chapel Hill; Carnegie Mellon, 2010–.
GERARD P. CORNUJEOLS, IBM University Professor of Operations Research – Ph.D., Cornell University; Carnegie Mellon, 1978–.
CARLOS CORONA, Assistant Professor of Accounting – Ph.D., Stanford University; Carnegie Mellon, 2010–.
W. ROBERT DALTON, Associate Teaching Professor of Economics, Emeritus – Ph.D., University of Missouri; Carnegie Mellon, 1985–.
ROBERT M. DAMMON, Dean; Professor of Financial Economics – Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 1984–.
JULIA G. DEEMS, Assistant Teaching Professor of Business Management Communication – M.A. English, The Ohio State University; Carnegie Mellon, 2011–.
TIMOTHY P. DERDENER, Assistant Professor of Economics and Strategy – Ph.D., University of Southern California; Carnegie Mellon, 2009–.
KENNETH B. DUNN, Professor of Financial Economics – Ph.D., Purdue University; Carnegie Mellon, 1979–.
S. THOMAS EMERSON, David T. and Lindsay J. Morgenthaler Distinguished Career Professor of Entrepreneurship - Carnegie Mellon University-Qatar – Ph.D., Rice University; Carnegie Mellon, 2000–.
DENNIS N. EPPLE, Thomas Lord Professor of Economics; Head, B.S. Economics Program – Ph.D., Princeton University; Carnegie Mellon, 1974–.
MICHAEL EWENS, Assistant Professor of Finance and Entrepreneurship – Ph.D., University of California, San Diego; Carnegie Mellon, 2010–.
MARIA MARTA FERREYRA, Associate Professor of Economics – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002–.
MARK FICHMAN, Associate Professor of Organizational Behavior and Theory – Ph.D., University of Michigan; Carnegie Mellon, 1980–.
JEFFREY GALAK, Assistant Professor of Marketing – Ph.D., New York University; Carnegie Mellon, 2009–.
WOLFGANG GATTERBAUER, Assistant Professor in Information Systems – Ph.D., Vienna University of Technology; Carnegie Mellon, 2011–.
ANISHA GHOSH, Assistant Professor of Finance – Ph.D., London School of Economics; Carnegie Mellon, 2009–.
BRENT GLOVER, Assistant Professor of Finance – Ph.D., University of Pennsylvania; Carnegie Mellon, 2011–.
JONATHAN C. GLOVER, Richard M. Cyert Professor of Management and Economics – Ph.D., The Ohio State University; Carnegie Mellon, 1992–.
MARVIN GOODFRIEND, Friends of Allan Meltzer Professor of Economics – Ph.D., Brown University; Carnegie Mellon, 2005–.
RICHARD C. GREEN, Senior Associate Dean, Faculty and Research; Richard M. and Margaret S. Cyert Chair; Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1982–.
W. MICHAEL GRIFFIN, Executive Director, Green Design Institute; Associate Research Professor; Engineering and Public Policy, Carnegie Institute of Technology and Tepper School of Business – Ph.D., University of Rhode Island; Carnegie Mellon, 2000–.
JOACHIM RYOEHI GROEGER, Assistant Professor of Economics – Ph.D., London School of Economics; Carnegie Mellon, 2010–.
ISA E. HAFALIR, Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.
DALE HERSHEY, Associate Teaching Professor of Law, Emeritus – LL.B., Harvard Law School; Carnegie Mellon, 1987–.
GEOFFREY HITCH, Assistant Teaching Professor of Acting and Business Communications – M.F.A., Carnegie Mellon; Carnegie Mellon, 1992–.
BURTON HOLLIFIELD, Professor of Financial Economics – Ph.D., Carnegie Mellon; Carnegie Mellon, 1998–.
JOHN HOOKER, T. Jerome Holleran Professor of Business Ethics and Social Responsibility; Professor of Operations Research; Director, Center for International Corporate Responsibility – Ph.D., Vanderbilt University; University of Tennessee; Carnegie Mellon, 1984 (Leave-of-Absece 2012-13)–.
YUJI IJIRI, R. M. Trueblood University Professor of Accounting and Economics, Emeritus – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1967–.
KINSKJURATH, Assistant Professor of Marketing – Ph.D., University of Pennsylvania; Carnegie Mellon, 2008–.
JOSEPH B. KADANE, Leonard J. Savage University Professor of Statistics and Social Sciences, Emeritus – Ph.D., Stanford University; Carnegie Mellon, 1969–.
KARAM KANG, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Pennsylvania; Carnegie Mellon, 2012–.
SUJNER KEEKE, Bosch Professor of Operations Management – Ph.D., University of Rochester; Carnegie Mellon, 1984–.
ONUR KESTEN, Associate Professor of Economics – Ph.D., University of Rochester; Carnegie Mellon, 2006–.
SHAM KEKERE, Associate Teaching Professor of Production and Operations Management - Carnegie Mellon University-Qatar – Ph.D., University of Rochester; Carnegie Mellon, 2006–.
FATMA KILINC-KARZAN, Assistant Professor of Operations Research – Ph.D., Georgia Institute of Technology; Carnegie Mellon, 2011–.
JAVIER F. PENA, Professor of Operations Research – Ph.D., Cornell University; Carnegie Mellon, 1992–.

STEVEN KLEPPER, Arthur Arton Hamerslag Professor of Economics and Social Sciences, Social and Decision Sciences, College of Humanities and Social Sciences and Joint Appointment at Tepper School of Business – Ph.D., Cornell University; Carnegie Mellon, 1980–.

DAVID KRAKHDAR, Professor of Organizations, H. John Heinz III College and Joint Appointment at Tepper School of Business – Ph.D., University of California, Irvine; Carnegie Mellon, 1991–.

ROBERT E. KRAUT, Herbert A. Simon Professor of Human-Computer Interaction, School of Computer Science and Joint Appointment at Tepper School of Business – Ph.D., Yale University; Carnegie Mellon, 1993–.

YAROSLAV KRYUKOV, Assistant Professor of Economics – Ph.D., Northwestern University; Carnegie Mellon, 2008–.

LARS-ALEXANDER KUEHN, Assistant Professor of Finance – Ph.D., University of British Columbia; Carnegie Mellon, 2008–.


DAVID L. LAMONT, Associate Teaching Professor; Director, Management Games – M.S.I.A., Carnegie Mellon University; Carnegie Mellon, 1984–.

REBECCALESSEM, Assistant Professor of Economics – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–.

JING LI, Assistant Professor of Accounting – Ph.D., Columbia University; Carnegie Mellon, 2009–.

PIERRE JINGHONG LIANG, Associate Professor of Accounting – Ph.D., University of Florida; Carnegie Mellon, 1998–.


JOHN H. MATHER, Executive Director, Masters Programs; Teaching Professor of Marketing – Ph.D., University of Arizona; Carnegie Mellon, 1992–.

DAVID S. MAWHINNEY, Director, Donald H. Jones Center for Entrepreneurship; Assistant Teaching Professor of Entrepreneurship – MBA, Carnegie Mellon University; Carnegie Mellon, 2011–.

BENNETT T. MCCALLUM, H. J. Heinz Professor of Economics – Ph.D., Rice University; Carnegie Mellon, 1981–.

J. PATRICK MCGINNIS, Assistant Teaching Professor of Business Management Communication – M.A., Pittsburg State University; Carnegie Mellon, 1999–.

ALLAN H. MELTZER, The Allan H. Meltzer University Professor of Political Economy – Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957–.


ROBERT T. MONROE, Associate Teaching Professor, Information Technology and Computer Science – Ph.D., Carnegie Mellon; Carnegie Mellon, 2004–.

ALAN MONTGOMERY, Associate Professor of Marketing – Ph.D., University of Chicago; Carnegie Mellon, 1999–.

CAREY MOREWEDGE, Assistant Professor of Marketing – Ph.D., Harvard University; Carnegie Mellon, 2007–.

CHRISTOPH MUELLER, Assistant Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2010–.

TRIDAS MUKHOPADHYAY, Deloitte Consulting Professor of e-Business; Professor in Information Systems – Ph.D., University of Michigan; Carnegie Mellon, 1986–.

MILDRED S. MYERS, Teaching Professor of Business Management Communications, Emerita – D.A., Carnegie Mellon University; Carnegie Mellon, 1984–.

JOHN R. O’BRIEN, Associate Professor of Accounting and Experimental Economics – Ph.D., University of Minnesota; Carnegie Mellon, 1984–.

EMILIO OSAMBELA, Assistant Professor of Finance – Ph.D., Swiss Finance Institute and Universite de lausanne; Carnegie Mellon, 2009–.

JAVIER P. PENA, Professor of Operations Research – Ph.D., Cornell University; Carnegie Mellon, 1999–.

NICOLAS PETROSKY-NADEAU, Assistant Professor of Economics – Ph.D., University of Quebec; Carnegie Mellon, 2009–.

EVELYN M. PIERCE, Associate Director, Accelerate Leadership Center; Associate Teaching Professor of Business Management Communication – M.F.A., University of Pittsburgh; Carnegie Mellon, 1993–.


DENISE M. ROUSSEAU, H. J. Heinz II University Professor of Organizational Behavior and Public Policy, Heinz College and Joint Appointment at Tepper School of Business – Ph.D., University of California at Berkeley; Carnegie Mellon, 1994–.

BRYAN R. ROUTLEDGE, Associate Professor of Finance – Ph.D., University of British Columbia; Carnegie Mellon, 1995–.

STEFANO SACCHETTO, Assistant Professor of Finance – Ph.D., London Business School; Carnegie Mellon, 2009–.

ALAN SCHEDLER-WOLF, Professor of Operations Management; Head, Ph.D. Program – Ph.D., Columbia University; Carnegie Mellon, 1996–.

NICOLA SECOMANDI, Associate Professor of Operations Management – Ph.D., University of Houston; Carnegie Mellon, 2003–.

DUANE J. SEPP, BNY Mellon Professor of Finance; Head, Master of Science in Computational Finance Program – Ph.D., University of Chicago; Carnegie Mellon, 1986–.

PATRICK W. SILEO, Associate Dean, Carnegie Mellon University-Qatar; Associate Teaching Professor of Economics and Finance - Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999–.

PARAM VIR SINGH, Assistant Professor in Information Systems – Ph.D., University of Washington, Seattle; Carnegie Mellon, 2008–.

MARVIN A. SIRBU, Professor of Engineering and Public Policy, Electrical and Computer Engineering, Carnegie Institute of Technology and Joint Appointment at Tepper School of Business – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985–.

CHRISTOPHER SLEET, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

MICHAEL D. SMITH, Professor of Information Technology and Marketing – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000–.

FALLAW B. SOWELL, Associate Professor of Economics – Ph.D., Duke University; Carnegie Mellon, 1988–.

CHESTER S. SPATT, Pamela R. and Kenneth B. Dunn Professor of Finance; Director, Center for Financial Markets – Ph.D., University of Pennsylvania; Carnegie Mellon, 1979–.

STEPHEN E. SPEAR, Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1962–.

KANNAN SRINIVASAN, Rohat Tolani Distinguished Professor in International Business; H. J. Heinz II Professor of Management, Marketing, and Information Systems – Ph.D., University of California, Los Angeles; Carnegie Mellon, 1986–.

ANTHONY P. STANTON, Teaching Professor of Graphic Media Management; Director, Graphic Media Management Program – Ph.D., University of Pittsburgh; Carnegie Mellon, 1996–.

JACK DOUGLAS STECHER, Assistant Professor of Accounting – Ph.D., University of Minnesota; Carnegie Mellon, 2008–.

SRI DHRAR T. TAYUR, The Ford Distinguished Research Chair; Professor of Operations Management – Ph.D., Cornell University; Carnegie Mellon, 1991–.

CHRISTOPHER I. TELMER, Associate Professor of Financial Economics – Ph.D., Queen’s University at Kingston (Canada); Carnegie Mellon, 1992–.

MICHAEL A. TRICK, Senior Associate Dean, Education; Harry B. and James H. Higgins Professor of Operations Research – Ph.D., Georgia Institute of Technology; Carnegie Mellon, 1988–.

DAVID E. TUNGATE, Associate Teaching Professor of Law – LL.B., University of Illinois School of Law; Carnegie Mellon, 1991–.

WILLEM-JAN VAN HOEVE, Assistant Professor of Operations Research – Ph.D., University of Amsterdam; Carnegie Mellon, 2007–.

JOACHIM VOSGERAU, Associate Professor of Marketing; Co-Director of the Center for Behavioral Decision Research (CBDR) – Ph.D., INSEAD; Carnegie Mellon, 2005–.
LAURIE R. WEINGART, Director, Accelerate Leadership Center; Carnegie Bosch Professor of Organizational Behavior and Theory – Ph.D., Northwestern University; Carnegie Mellon, 1989–.

GEORGE M. WHITE, Associate Teaching Professor of Entrepreneurship - Carnegie Mellon University-Qatar – Ph.D., University of Oregon; Carnegie Mellon, 2007–.

JEFFREY R. WILLIAMS, Professor of Business Strategy – Ph.D., University of Michigan; Carnegie Mellon, 1977–.

ANITA WILLIAMS WOOLLEY, Assistant Professor of Organizational Behavior and Theory – Ph.D., Harvard University; Carnegie Mellon, 2008–.

SEVIN YEL TEKIN, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

M. BUMIN YENMEZ, Assistant Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2010–.

ARIEL ZETLIN-JONES, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Minnesota; Carnegie Mellon, 2012–.

Visiting Faculty

ROBERT C. BLATTBERG, Executive Director, Center for Marketing Technology and Information; Timothy W. McQuire Distinguished Service Professor of Marketing – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008–.

ANNELIES DEUSS, Visiting Assistant Professor of Economics – Ph.D., Cornell University; Carnegie Mellon, 2010–.

DANIEL KAISER, Visiting Assistant Professor of Accounting – Ph.D. (Expected 2012), Ludwig-Maximilians University; Carnegie Mellon, 2012–.

RADHIKA LUNAWAT, Visiting Assistant Professor of Accounting – Ph.D., University of Minnesota; Carnegie Mellon, 2012–.

RONALD PLACONE, Visiting Associate Professor of Business Management Communication – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2012–.

RICHARD SAAVEDRA, Visiting Associate Professor of Organizational Behavior and Theory – Ph.D., University of Michigan; Carnegie Mellon, 2012–.

Adjunct Faculty

ELAINE HYDER, Adjunct Professor of Organizational Behavior and Theory – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2009–.

ROBERT M. ATKINSON, II, Adjunct Professor of Marketing – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002–.

RICHARD L. BRYANT, Adjunct Professor of Business; Executive Director, Master of Science in Computational Finance Program – M.B.A., Carnegie Mellon University; Carnegie Mellon, 1999–.

BABS BAILEY CARRYER, Adjunct Professor of Entrepreneurship – M.P.M., Carnegie Mellon University; Carnegie Mellon, 1998–.

JOSEPH S. HORNACK, Adjunct Professor of Law – J.D., Rutgers University; Carnegie Mellon, 1990–.

ELIF INCEKARA HAFALIR, Adjunct Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.
Undergraduate Business Administration Program

Milton L. Cofield, Ph.D., Executive Director
Tepper School, Room 141
miltonc@andrew.cmu.edu

The Tepper School program in undergraduate business education is intended for students interested in an undergraduate management educational experience that is broad and based upon the liberal arts, quantitative studies and analytical reasoning as its foundation. Such a program is both intellectually strong and flexible enough to accommodate the interests of students with diverse goals, ranging from beginning a career to graduate study.

The curriculum is designed around a central core of courses in the liberal arts, the functional areas of business, economics, mathematics and computing course requirements. To this is added a requirement for in-depth study in one of the core functional business areas such as finance, information systems, marketing, entrepreneurship or manufacturing management. Finally, the curriculum requires all students to have a minor in the curricula of another college in order to obtain the additional breadth and flexibility that promotes confidence in one’s knowledge and its benefits for a lifetime. We believe this curriculum structure is that needed for those who will be leaders in the increasingly global business and political environment in which organizations of the future will pursue their goals.

Our curriculum prepares students to begin their professional careers in all areas of management and they do so in some of the world’s leading service, manufacturing, and governmental organizations. Many go on to graduate study in law, economics, finance and policy studies at the leading universities in the world.

In addition to the major in business administration, we offer the opportunity for a minor or second major to students in other programs of the university. If you are seriously interested in management education in an environment that offers the best undergraduate experience, please contact the undergraduate business advisors in the Tepper School of Business.

Business Administration Major Requirements

To receive a degree in business administration, students must complete at least 364 units, consisting of three basic core sequences, as well as breadth, track and minor requirements.

These requirements break down as follows:

Functional Business Core 111 Units
70-100 Global Business 9
70-122 Introduction to Accounting 9
70-201 Professional and Service Projects 9
70-311 Organizational Behavior 9
70-322 Business, Society and Ethics 9
70-340 Business Communications 9
70-345 Business Presentations 9
70-371 Product/Operations Management 9
70-381 Marketing 9
70-391 Finance 9
70-401 Management Game 12
70-451 Management Information Systems 9

Economics Core 27 units
73-100 Principles of Economics 9
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9

Mathematics/Computing Core Units 59 units
15-110 Principles of Computing 10
21-120 Differential and Integral Calculus 10
21-256 Multivariate Analysis 1
21-257 Models and Methods for Optimization 2
70-207 Probability and Statistics for Business Applications 9
70-208 Regression Analysis 9
99-101/102 Computing @ Carnegie Mellon 9

Breadth Requirements 63 Units

For a list of courses in each category, please see the Undergraduate Business Administration website: www.tepper.cmu.edu.

Required:
76-101 Interpretation and Argument 9
79-104 Global Histories 9

Science & Technology
Cognition, Choice & Behavior
Political & Social Institutions
Creative Production & Reflection
Cultural Analysis

A TOTAL OF SEVEN BREADTH COURSES IS REQUIRED.

Track Requirements 54 Units

A track consists of a menu of courses (both required and elective) that the student must complete in order to obtain in-depth knowledge of a particular functional area of management expertise.

Tracks:

- Computing and Information Technology
- Entrepreneurship
- Finance
- General Management
- Graphic Media Management
- International Management
- Manufacturing Management and Consulting
- Marketing

Minor Requirement 54 Units

All business students are required to complete a minor in another department. Students may select any minor offered at Carnegie Mellon to fulfill this requirement. Minors that blend well with the business curriculum include: Psychology, Statistics, Economics, Communication Design, and Policy & Management. Students should consult the undergraduate catalog regarding the specific requirements of any minor and should meet with their advisor to discuss their choice.

Suggested Course Plan

What follows is a suggested course plan for Business Administration students. Be careful to observe any pre- and co-requisite requirements for each course.

First Year

Fall Units
21-120 Differential and Integral Calculus 10
70-100 Global Business 9
73-100 Principles of Economics 9
76-101 Interpretation and Argument 9
xx-xxx Breadth course 9
99-101/102 Computing @ Carnegie Mellon 3

49

Spring

Units
21-256 Multivariate Analysis 9
73-230 Intermediate Microeconomics 9
79-104 Global Histories 9
15-110 Principles of Computing 10
xx-xxx Breadth course 9

46

Sophomore Year

Fall Units
21-257 Models and Methods for Optimization 9
73-240 Intermediate Macroeconomics 9
70-207 Probability and Statistics for Business Applications 9
70-122 Introduction to Accounting 9
xx-xxx Breadth course 9

45

Spring

Units
70-208 Regression Analysis 9
70-311 Organizational Behavior 9
70-340 Business Communications 9
or 21-292 Operations Research I, offered in spring semesters only

Junior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-381 Marketing I</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-201 Professional and Service Projects</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-401 Management Game</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>70-3xx Minor Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Minor Course</td>
<td>9</td>
</tr>
<tr>
<td>Spring</td>
<td>70-332 Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-345 Business Presentations</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Minor Course</td>
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</tr>
<tr>
<td></td>
<td>xx-xxx Minor Course</td>
<td>9</td>
</tr>
<tr>
<td>Senior Year</td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
<td>9</td>
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<tr>
<td></td>
<td>xx-xxx Minor Course</td>
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</tr>
<tr>
<td></td>
<td>xx-xxx Minor Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-201 Professional and Service Projects</td>
<td>9</td>
</tr>
</tbody>
</table>

Total units required: 364

Bachelor of Science in Computational Finance

The Bachelor of Science in Computational Finance is an Intercollege Program. Students who pursue Computational Finance as their primary major may elect to have either the Mellon College of Science (MCS) or the Tepper School of Business (Tepper) as their home college. The coursework required for the major is the same in either case, with the exception of the breadth component requirement and those of the functional business core.

Tepper School Students must complete the breadth requirements of the business administration program. Additionally, they must complete the Functional Business Core. The complete sequence of courses for this major may be found in the inter-college Programs section of the catalog. Students who are thinking of the BSCF major should meet with an academic advisor in the Tepper School as soon as their interest is firm in order to make sure they are completing the correct sequence of courses.

Additional Major Requirements

Students may apply to be admitted to the study of an additional major in business administration in their junior year. Applications will be accepted two weeks prior to Spring & Fall Registration week.

The decision to accept a student into the additional major will be based upon a variety of factors including:

- An overall GPA of 3.25 or greater;
- Having completed or being currently enrolled in all of the mathematics & statistics, economics, and computing requirements of the business administration degree prior to submitting an application for admission to the additional major;
- The extent of completion of the business administration functional core course requirements;
- The availability of admission enrollment spaces in the graduating class year for which the student is applying.

Acceptance in the additional major is subject to the University policy which states that the ability to satisfy the requirements for an additional major cannot be guaranteed for any student and will be based upon course availability and the time the student is willing to invest to satisfy all of the requirements of the additional major. In some cases this might require more than 8 semesters of undergraduate study.

The student seeking an additional major in business administration is required to complete all of the requirements listed below without substitution:

Course Requirements

Mathematics and Statistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10-20</td>
</tr>
<tr>
<td>6.21-111 and Calculus II</td>
<td>9</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-257 Models and Methods for Optimization</td>
<td>9</td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
<td>9</td>
</tr>
<tr>
<td>70-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>70-208 Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>21-113 Calculus I</td>
<td>10</td>
</tr>
<tr>
<td>21-112 Calculus II</td>
<td>10</td>
</tr>
</tbody>
</table>

66.76

Computing

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>99-101/102 Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>15-110 Principles of Computing</td>
<td>10</td>
</tr>
</tbody>
</table>

Economics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
</tbody>
</table>

Business

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-332 Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>70-345 Business Presentations</td>
<td>9</td>
</tr>
<tr>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-381 Marketing I</td>
<td>9</td>
</tr>
<tr>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td>70-401 Management Game</td>
<td>12</td>
</tr>
<tr>
<td>70-3xx/4xx Electives (2)</td>
<td>84</td>
</tr>
</tbody>
</table>

4 Students in IS and CS must select a 70-4xx course from the Computing and Information Technology Track.

5 Students seeking an additional major in business administration may not substitute 70-440 for 70-401.

Minor in Business Administration

The minor in business administration requires a total of 6 courses or 54 units of which two courses must be 70-381 Marketing I and 70-100 Principles of Economics. The remaining 4 courses can be chosen from any offered in the department. Some of the most common choices that have been made are from the following list:

(A Total of 54 units or 6 courses):

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics (Required)</td>
<td>9</td>
</tr>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-381 Marketing I (Required)</td>
<td>9</td>
</tr>
<tr>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td>70-342 Managing Across Cultures</td>
<td>9</td>
</tr>
<tr>
<td>70-430 International Management</td>
<td>9</td>
</tr>
<tr>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td>70-460 International Marketing</td>
<td>9</td>
</tr>
<tr>
<td>70-481 Marketing Research</td>
<td>9</td>
</tr>
<tr>
<td>70-483 Advertising and Marketing Communications</td>
<td>9</td>
</tr>
</tbody>
</table>

6 Students in Information Systems and Computer Science cannot take 70-451; they may select another 70-4xx course from the Computing and Information Technology (CIT) track.
Business Administration Policies

Transfer Students

The undergraduate business administration program does not accept students for transfer admission from any academic institution outside of Carnegie Mellon University.

Current Carnegie Mellon University students who are in other colleges may seek to transfer into the undergraduate business administration program on a limited basis. Freshman students will not be considered for transfer until their Spring mid-semester grades for their first year of study have been posted. All other students may apply for transfer by completing the Transfer Application that is found online in the undergraduate business program pages of the Tepper School website (http://www.tepper.cmu.edu/undergraduate-business). Students may apply for transfer two times in each academic year at the mid-semester of the Fall and Spring terms. Successful transfer is limited by both space and academic performance criteria. Students may be denied transfer if their academic performance prior to seeking transfer indicates that they will be unable to complete degree requirements in a timely way or if they have serious academic performance deficiencies.

Transfer of Course Credit

Students may receive credit for a maximum of three courses (27 units) of course work taken at other institutions and only provided they have received prior approval to take these courses for degree credit. Students seeking an additional major may only receive credit for a maximum of two courses (18 units), and those completing a minor may only receive credit for one course (9 units) through transferred credit. No transferred credit will be awarded for any course in which the grade received is less than a B.

Students receiving 36 units or more of AP/IB/Cambridge credit towards their degree requirements will not be eligible to transfer any additional coursework unless it is for an approved study abroad experience. Credit for college courses taken prior to enrolling at Carnegie Mellon will be at the discretion of the department.

No courses taken online will be accepted for transfer credit.

Pass/Fail

Students may use a maximum of 9 units Pass/Fail credit towards their graduation requirement.

Academic Advising

Students are required to meet with their advisor at least once each semester to ensure that they are making normal progress towards their degree. An appointment for advising may be scheduled at any time by sending a request to uba@andrew.cmu.edu.

Dean’s List

Students who receive a semester QPA of 3.50 or higher (with at least 45 factorable units and receiving no incompletes) will be placed on the Dean’s List for that semester.

The College Honors Program

Students with outstanding records (minimum QPA of 3.75) and with at least 270 units of credit are invited to undertake an honor’s thesis project under the direction of a faculty member for 18 units of credit. Students meeting these criteria are highly encouraged to consider the honor’s thesis option. For more information about the honor’s thesis option, please see the course description for 70-500 or contact their advisor.

Graduation Requirements

In order to graduate with the Bachelor of Science in Business Administration, students must meet all requirements specified for the program with a cumulative QPA of at least 2.00 and 364 earned units.

Students must also meet all university residence requirements and all financial obligations to the university before being awarded a degree. It is the student’s responsibility to make certain they meet all of the requirements for graduation by consulting with our advising staff on a regular basis.
Undergraduate Economics Program

Dennis Epple, Head of Economics
Carol B. Goldberg, Director of Undergraduate Economics
Program Office: Tepper School of Business, Room 139
E-mail: econprog@andrew.cmu.edu

Advising Appointment Online Scheduler: www.tepper.cmu.edu/econadvising
http://www.tepper.cmu.edu/undergraduate-economics

At its most fundamental level, economics is the study of how scarce resources are allocated. What will be produced and consumed, how much, and by whom? These questions, central to the well-being of people throughout the world, are the focus of economics. Economists identify, model, and analyze problems, developing meaningful solutions for the challenges confronting society. Economists are active participants in the processes and institutions through which the pressing concerns of society are addressed. Economists help businesses, political bodies, and other organizations make better decisions through the application of economic analysis, development of market strategies, promotion of regulatory structures, and formulation of appropriate government policies. Increasingly, economists are taking advantage of new technologies to design and implement new markets and exchange mechanisms.

Carnegie Mellon University enjoys a rich history of innovative research in the field of economics. By bringing together rigorous theoretical and empirical work, the University supports some of the very best research. Eight of our past and present faculty have been awarded the Nobel Prize in Economics. In the classroom, we bring the same rigorous, innovative approach to enable our students to develop their talents and realize the potential of their tremendous analytical skills. Our students also benefit from a strong culture of interdisciplinary collaboration and exposure to a broad range of research.

The Undergraduate Economics Program has a unique position at Carnegie Mellon University. It is the sole undergraduate program that is a joint program of the Tepper School of Business and the Dietrich College of Humanities and Social Sciences. The combination of research strengths (Tepper has been home to eight Nobel Laureates in Economics) and commitment to liberal arts and interdisciplinary studies (Dietrich has “the most creative general education program of any American university” – New York Times) provides our undergraduates with a world-class economics program.

Economics majors are considered members of both colleges and enjoy their full support and services of both. Undergraduate economics students should consult the program’s website and handbook for details about applicable Tepper and Dietrich academic policies and procedures.

Educational Objectives

The Undergraduate Economics Program offers a range of degrees in economics designed to develop strong analytical skills and a solid foundation in the discipline of economics. More specifically, measurable objectives for our economics curriculum are the following:

• Students should be able to identify, explain, and use economic concepts, theories, models, and data-analytic techniques.
• Students should acquire and use knowledge of economics, mathematics, statistics, and computing flexibly in a variety of contexts, providing the foundation for success in graduate studies and careers in the public and private sectors.
• Students should be able to apply their economic tools to formulate positions on a wide range of social and economic problems and engage effectively in policy debates.
• Students should use the investigative skills necessary for conducting original economic research and participating effectively in project teams.
• Students should be able to deliver effective presentations in which they combine visual communication design with oral arguments and/or the written word.

Advising

The Undergraduate Economics Program is committed to providing students with the opportunity to have meaningful and informative discussions about their academic, intellectual, and career interests with a wide range of advisors and mentors. In college, advising meetings are not the same thing as “being sent to the principal’s office in high school.” Instead, these are extended discussions which may address both immediate and long-term interests, concerns, and desires/needs.

The economics curriculum is cumulative, higher-level courses build upon the foundations learned in the core course. This results in students needing to be aware of course-sequencing and the schedule of classes. Students are encouraged to meet frequently with their Undergraduate Economics Program academic advisor to ensure that their courses fulfill the requirements towards their degree and are appropriately sequenced. Historically, successful students typically checked-in with their advisor frequently and sought the advice of their academic advisor in selecting courses, pursuing additional degrees, and planning ahead for study abroad.

All students taking economics courses are invited to meet with an economics advisor. Students pursuing a degree in economics are assigned an economics advisor who meets with them on a regular basis.

To facilitate scheduling advising meetings, please use the online appointment scheduler found on the Undergraduate Economics Program’s Advising Website (http://www.tepper.cmu.edu/econadvising) (www.tepper.cmu.edu/econadvising).

Curricula

In order to accommodate students’ wide variety of goals, four primary degree programs are available: Bachelor of Arts in Economics, Bachelor of Science in Economics, Bachelor of Science and Mathematical Sciences (jointly administered by the Department of Mathematics and the Undergraduate Economics Program), and Bachelor of Science in Economics and Statistics (jointly administered by the Department of Statistics and the Undergraduate Economics Program). The four major degree programs have been designed to provide students with a solid understanding of the central theories and analytical tools of the field of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. The four degrees produce strong analytical thinkers who are able to model and analyze complex problems.

Graduates of the Undergraduate Economics Program gain employment as economic analysts in both the private and public sectors; pursue advanced professional degrees in business, law, and public policy; as well as enter into Ph.D. programs in economics, statistics, finance, and related fields.

First-year students are not expected to know which degree option they wish to pursue. For this reason, the first-year curricula are quite similar for the four degrees. As students become involved in their course work, participate in the extra- and co-curricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes evident.

For students who major in other academic fields, additional major programs in Economics and in Economics and Statistics and two minor degree program in Economics and in Innovation, Economics, and Entrepreneurship are available. Information about these degrees can be found following the discussions about the major curricula.

Major Degree Requirements and Sample Schedules

In addition to completing a minimum 360 units and fulfilling both the Dietrich General Education requirements and all University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economic theory, and economic analysis, as well as a set of advanced electives and other specialized courses.

Following the list of requirements for each degree are sample four-year course schedules for a student pursuing undergraduate degrees in economics. As there are many different ways of completing the requirements, students are strongly encouraged to meet with an economics advisor to tailor their courses to their own particular needs. Students are responsible for ensuring that they understand all of the program requirements and that they meet the necessary conditions for graduation. When planning course schedules, students must give consideration to all prerequisite and co-requisite requirements.

B.A. in Economics

The B.A. in Economics curriculum is designed to provide students with a deep understanding of economic theory, quantitative economic analysis, and how economics can be used to solve current social problems. It is a goal of the degree program to have students develop an ability to observe and identify contemporary problems, and then provide solutions. Built into the degree is the opportunity to study political, historical, cultural, and social institutions from other CMU departments; these courses are referred to as “Special Electives”. The advanced data analysis component of the B.A. in
Economics Curriculum pays additional attention to ordinal data and the study of surveys. The capstone of the curriculum is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies.

B.A. in Economics Curriculum

Mathematics Prerequisites (19 units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Sophomore Economics Colloquium (1 unit)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-450 Economics Colloquium</td>
<td>1</td>
</tr>
</tbody>
</table>

Writing Requirement (9 units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-270 Writing for Economists</td>
<td>9</td>
</tr>
</tbody>
</table>

Economic Theory Requirements (27 units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
</tbody>
</table>

Economic History Requirement (9 units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-310 Evolution of Economic Ideas and Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Quantitative Analysis Requirements (54 Units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>or 36-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>or 70-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
</tr>
<tr>
<td>or 36-208 Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 70-208 Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>73-407 Fundamentals of Statistical Modeling</td>
<td>9</td>
</tr>
<tr>
<td>36-303 Sampling, Survey and Society</td>
<td>9</td>
</tr>
</tbody>
</table>

Advanced Economics Electives (36 Units)

Students must take four advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as selected courses designated by the Program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Special Electives (27 Units)

Students must take three special elective courses in the humanities and social sciences. The complete list of courses designated as special electives is maintained, revised, and published online each semester by the Undergraduate Economics Program. The list below is representative of the courses that qualify as "Special Electives;" this is not an exhaustive list of qualifying courses. In particular, the graduate courses from Heinz College which open to B.A. in Economics students are not presented.

Course List

<table>
<thead>
<tr>
<th>Representative List of &quot;Special Elective&quot; Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-221 Development and Democracy in Latin America</td>
<td>9</td>
</tr>
<tr>
<td>79-246 Industrial America</td>
<td>9</td>
</tr>
<tr>
<td>79-300 History of American Public Policy</td>
<td>9</td>
</tr>
<tr>
<td>79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967</td>
<td>9</td>
</tr>
<tr>
<td>79-335 Drug Use and Drug Policy</td>
<td>9</td>
</tr>
<tr>
<td>79-375 China’s Environmental Crisis</td>
<td>9</td>
</tr>
<tr>
<td>79-386 Entrepreneurs in Africa, Past, Present and Future</td>
<td>9</td>
</tr>
<tr>
<td>80-130 Introduction to Ethics</td>
<td>9</td>
</tr>
<tr>
<td>80-136 Social Structure, Public Policy &amp; Ethics</td>
<td>9</td>
</tr>
<tr>
<td>80-221 Philosophy of Social Science</td>
<td>9</td>
</tr>
<tr>
<td>80-235 Political Philosophy</td>
<td>9</td>
</tr>
<tr>
<td>88-260 Organizations</td>
<td>9</td>
</tr>
<tr>
<td>80-305 Rational Choice</td>
<td>9</td>
</tr>
<tr>
<td>80-321 Causation, Law, and Social Policy</td>
<td>9</td>
</tr>
<tr>
<td>80-348 Health Development and Human Rights</td>
<td>9</td>
</tr>
<tr>
<td>88-365 Behavioral Economics and Public Policy</td>
<td>9</td>
</tr>
<tr>
<td>88-387 Social Norms and Economics</td>
<td>9</td>
</tr>
<tr>
<td>88-412 Economics of Global Warming</td>
<td>9</td>
</tr>
</tbody>
</table>

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-497 Senior Project</td>
<td>9</td>
</tr>
</tbody>
</table>

Sample Schedule for B.A. in Economics

The sample schedule below is an illustration of how a student might plan their four-year schedule. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pick up additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actually the "minimum" set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman Fall

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Sophomore Fall

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
</tr>
</tbody>
</table>

Junior Fall

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-310 Evolution of Economic Ideas and Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Senior Fall

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-497 Senior Project</td>
<td>9</td>
</tr>
</tbody>
</table>

Economics Elective

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-412 Economics of Global Warming</td>
<td>9</td>
</tr>
</tbody>
</table>

B.S. in Economics Curriculum

Mathematics Requirement (29 Units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>or 21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Sophomore Colloquium (1 Unit)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-450 Economics Colloquium</td>
<td>1</td>
</tr>
</tbody>
</table>

Quantitative Analysis Requirements (27 Units)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>or 36-217 Probability Theory and Random Processes</td>
<td>9</td>
</tr>
</tbody>
</table>
or 21-325 Probability
36-226 Introduction to Statistical Inference 9
73-363 Econometrics 9  

Writing Requirement (9 Units)
73-270 Writing for Economists 9  

Economic Theory Requirements (39 Units)
73-100 Principles of Economics 9
73-252 Advanced Microeconomic Theory 6
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-253 Advanced Macroeconomic Theory 6  

Advanced Economics Electives (45 Units)
Students must take five advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495. For the purpose of these requirements, the Undergraduate Economics Program may designate as advanced electives courses from other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)
73-497 Senior Project 9
or 73-500 Tepper College Honors Thesis I & 73-501 and Tepper College Honors Thesis II & 66-501 and H&SS Senior Honors Thesis II 9

Sample Course Schedule for the B.S. in Economics
The sample schedule below is an illustration of how a student might plan their four-year schedule. This schedule has been designed to highlight the following characteristics of the degree program: 1) the workload is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pick up additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actual “minimum” set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman
Fall 21-120 Differential Calculus and Integral Calculus 10
Spring 21-121 Three Dimensions of Microeconomics 10

Sophomore
Fall 36-201 Statistical Reasoning and Practice 10
Spring 36-202 Statistical Methods 10

Fall 36-225 Introduction to Probability Theory 9
Spring 73-252 Advanced Microeconomic Theory 9

Fall 73-100 Principles of Economics 9
Spring 73-230 Intermediate Microeconomics 9

Fall 73-240 Intermediate Macroeconomics 9
Spring 73-450 Economics Colloquium 9

Fall 73-363 Econometrics 9  

Junior
Fall 73-497 Senior Project 9
Spring Economics Elective 9

Senior
Fall Economics Elective 9
Spring Economics Elective 9

*In each semester, ----- represents courses (not directly required for the major).

B.S. in Economics and Mathematical Sciences
The B.S. in Economics and Mathematical Sciences is a collaborative effort between the Department of Mathematical Sciences and the Undergraduate Economics Program. Combining advanced mathematics with advanced economic theory is the hallmark of this curriculum. The curriculum provides students with courses that complement and develop depth of understanding of economic theory, applied economics, and applied mathematics. This degree offers an integrated curriculum, guiding students through a program of coursework that exploits and builds upon the synergies between mathematics and economics. This degree program equips students with the mathematical tools that are essential for success in Ph.D. programs in economics; mathematics; and key functional areas of business including finance, accounting, marketing, and information systems. Students pursuing this degree will be well prepared for the beginning of their research careers in academia, government, and industry. There are a limited number of student openings in this program; interested students may apply as early as their sophomore year.

B.S. in Economics and Mathematical Sciences Curriculum

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Theory Requirements (39 Units)</td>
<td></td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-252 Advanced Microeconomic Theory</td>
<td>6</td>
</tr>
<tr>
<td>73-253 Advanced Macroeconomic Theory</td>
<td>6</td>
</tr>
<tr>
<td>Quantitative Analysis Requirements (36 Units)</td>
<td></td>
</tr>
<tr>
<td>36-225 Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>or 36-217 Probability Theory and Random Processes</td>
<td></td>
</tr>
<tr>
<td>or 21-325 Probability</td>
<td></td>
</tr>
<tr>
<td>36-226 Introduction to Statistical Inference</td>
<td>9</td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td>9</td>
</tr>
<tr>
<td>73-363 Econometrics</td>
<td>9</td>
</tr>
<tr>
<td>Mathematical Science Requirements (93 Units)</td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-121 Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>21-355 Principles of Real Analysis I</td>
<td>9</td>
</tr>
<tr>
<td>21-356 Principles of Real Analysis II</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>Programming Requirement (9 Units)</td>
<td></td>
</tr>
<tr>
<td>15-110 Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>Writing Requirement (9 Units)</td>
<td></td>
</tr>
<tr>
<td>73-270 Writing for Economists</td>
<td>9</td>
</tr>
</tbody>
</table>

Advanced Economic Electives (27 Units)
Students must take three advanced economics elective courses. Advanced Elective courses are those courses numbered 73-300 through 73-495, as well as courses designated by the Undergraduate Economics Program which are offered by other departments/programs. At least one of the courses must have Advanced Microeconomic Analysis or Advanced Macroeconomics Analysis as a prerequisite. Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability.

Recommended Advanced Economics Electives:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-310 Evolution of Economic Ideas and Analysis</td>
<td>9</td>
</tr>
<tr>
<td>73-347 Game Theory for Economists</td>
<td>9</td>
</tr>
<tr>
<td>73-392 Financial Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-405 Introduction to Dynamic Economics</td>
<td>9</td>
</tr>
</tbody>
</table>

Mathematical Science Depth Electives (27 Units)
Students must take three advanced mathematics depth courses. Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability.

Recommended Mathematical Science Depth Electives:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-292 Operations Research I</td>
<td>9</td>
</tr>
<tr>
<td>21-329 Set Theory</td>
<td>9</td>
</tr>
<tr>
<td>21-365 Projects in Applied Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-366 Topics in Applied Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-371 Functions of a Complex Variable</td>
<td>9</td>
</tr>
<tr>
<td>21-374 Field Theory</td>
<td>9</td>
</tr>
</tbody>
</table>
## The Major in Economics and Statistics

**Faculty Advisor:** Rebecca Nugent
**Office:** Baker Hall 132A
**Email:** acadcoord@stat.cmu.edu

The major in economics and statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

The requirements for the B.S. in Economics and Statistics are the following:

### I. Prerequisites 66/76 units

#### Course List

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>5-10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-240</td>
<td>Matrix Algebra with Applications</td>
<td>10</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrices and Linear Transformations</td>
<td>10</td>
</tr>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
<td>9</td>
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</table>

#### 1. Mathematical Foundations 39 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-240</td>
<td>Matrix Algebra with Applications</td>
<td>10</td>
</tr>
<tr>
<td>or 21-241</td>
<td>Matrices and Linear Transformations</td>
<td>10</td>
</tr>
</tbody>
</table>

#### 2. Economics Foundations 9 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
<td>9</td>
</tr>
</tbody>
</table>

#### 3. Statistical Foundations 18 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201</td>
<td>Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
</tbody>
</table>

**Notes:**
- *Mini Courses
- **Students who enter the program with 36-225/226 should discuss options with their advisors.
- **In order to be a major in good standing, a grade of C or better is required in 36-225 (or equivalents), 36-226 and 36-401. Otherwise you will not be allowed to continue in the major.
- Students must take two advanced economics elective courses (numbered 73-300 through 73-495) and two advanced statistics elective courses (numbered 36-300 through 36-495). A fifth advanced elective is required and can be chosen from either statistics or economics.

**Total number of units for the major 195 units**

**Total number of units for the degree 360 units**

## Sample Program

The following sample program illustrates one way to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see footnotes below the schedule).
### Supplemental Programs

#### Honors Program in Economics

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. For more information, consult the Dietrich Honors Program website (http://www.heinz.cmu.edu/school-of-public-policy-management/arts-management/tepper-senior-honors-program-in-economics) provides qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. The primary rewards of participating in the Honors Program in Economics are three-fold. First comes the satisfaction of undertaking and completing an original piece of research. Working independently or with a faculty member to identify a research question and claim ownership of its discovery process is a rewarding experience. Second is the opportunity to challenge oneself intellectually. The third advantage is the opportunity to graduate with Tepper Honors. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience.

Students are invited into the Tepper Senior Honors Program in Economics (http://tepper.cmu.edu/undergraduate-economics/academics/curricula/tepper-senior-honors-program-in-economics) provides qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. The primary rewards of participating in the Honors Program in Economics are three-fold. First comes the satisfaction of undertaking and completing an original piece of research. Working independently or with a faculty member to identify a research question and claim ownership of its discovery process is a rewarding experience. Second is the opportunity to challenge oneself intellectually. The third advantage is the opportunity to graduate with Tepper Honors. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience.

#### Accelerated Master’s Degree Programs

Accelerated Master’s Degree programs enable exceptional students to earn both an undergraduate degree and a master’s degree by remaining one additional year at Carnegie Mellon. The Heinz College of Public Policy and Management offers four professional accelerated masters degree programs: Master of Science in Arts Administration (http://www.heinz.cmu.edu/school-of-public-policy-management/arts-management-mam), Master of Science in Health Care and Policy Management (http://www.heinz.cmu.edu/school-of-public-policy-management/healthcare-policy-management-hcpm), Master of Information Systems Management (http://www.heinz.cmu.edu/school-of-information-systems-and-management/information-systems-management-mism), and Master of Science in Public Policy and Management (http://www.heinz.cmu.edu/school-of-public-policy-management/public-policy-management-mpppm). The Tepper School of Business offers one accelerated professional degree, a Master in Business Administration (http://tepper.cmu.edu/mba). For more details, visit the Accelerated Master’s Degree (http://tepper.cmu.edu/undergraduate-economics/academics/curricula/accelerated-masters-degree-programs) Programs site on the Undergraduate Economics Program website.

### Preparation for Ph.D. Programs

The Undergraduate Economics Program has been successful in preparing students for admission into the nation’s most competitive doctoral programs. Students interested in pursuing a career in research are encouraged to meet with the Director of the Undergraduate Economics Program early in their undergraduate careers.

### Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree completion of the requirements for the B.S. in Economics or the B.S. in Economics and Statistics. In addition, the student’s total units complete must be at least 90 units in excess of the requirement for the student’s other degree(s) or at least 450 units, whichever is greater. Interested students should meet with an economics advisor.

### Additional Major in Economics Curriculum

All university students are eligible to pursue an additional major in economics in conjunction with a major in any department in the university other than economics. The requirements for the Additional Major in Economics are the same as those for the B.S. in Economics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics are typically asked to take additional advanced economics electives.

### Additional Major in Economics and Statistics Curriculum

All university students are eligible to pursue a major in economics and statistics in conjunction with a major in any department in the university other than economics. The requirements for the Additional Major in Economics in Statistics are the same as those for the B.S. in Economics and Statistics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics and Statistics are typically asked to take additional advanced economics or statistics electives.

### Minor in Economics

The Minor in Economics degree program provides students with a solid understanding of economic theory and data analysis.

All university students are eligible to pursue the Minor in Economics in conjunction with a major in any other department in the university. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor.

#### Mathematics Requirements (19 Units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Economic Theory Requirements (27 Units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
</tbody>
</table>

*Some students may choose to focus their minor in microeconomics theory and applications. These students may elect not to take 73-240 Intermediate Macroeconomics and, instead, replace it with an additional advanced economics or statistics elective.

#### Quantitative Analysis Requirements (27 Units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td>9</td>
</tr>
<tr>
<td>or 21-325 Probability</td>
<td></td>
</tr>
<tr>
<td>or 36-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>or 36-217 Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>or 36-220 Engineering Statistics and Quality Control</td>
<td>9</td>
</tr>
<tr>
<td>or 36-225 Introduction to Probability Theory</td>
<td>9</td>
</tr>
<tr>
<td>or 70-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>36-202 Statistical Methods</td>
<td>9</td>
</tr>
</tbody>
</table>
Advanced Economics Electives (18 Units)

Students must take two advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as courses designated by the program offered by other departments/programs.

Additionally, students may work with their economics advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Minor in Innovation, Economics, and Entrepreneurship

Innovation (both technological and social) and entrepreneurship are the catalytic forces behind modern economic growth. Today, both developing and developed countries are looking for ways to promote and sustain growth. This minor builds on study of the behavior of individuals and firms to foster an understanding of how organizations manage innovation and learning, how firms and the market respond to technological change, and how entrepreneurs are able to turn ideas into goods and services and new markets.

All university students are eligible to pursue the Minor in Innovation, Economics, and Entrepreneurship in conjunction with any major in the university. The curriculum consists of six courses (54-57 units) of which five core courses are required and the sixth course (an elective) may be chosen from a list of options from across the University.

In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis</td>
<td>9</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td></td>
</tr>
</tbody>
</table>

Required Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-415</td>
<td>Introduction to Entrepreneurship</td>
<td>9</td>
</tr>
<tr>
<td>70-437</td>
<td>Organizational Learning and Knowledge Management</td>
<td>9</td>
</tr>
<tr>
<td>70-438</td>
<td>Commercialization and Innovation</td>
<td>9</td>
</tr>
<tr>
<td>73-465</td>
<td>Technology Strategy</td>
<td>9</td>
</tr>
<tr>
<td>73-407</td>
<td>Fundamentals of Statistical Modeling</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: Students who have completed 73-363 or 36-401 are exempted from 73-407.

Electives*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-320</td>
<td>Social Web</td>
<td>12</td>
</tr>
<tr>
<td>08-533</td>
<td>Privacy, Policy, Law and Technology</td>
<td>9</td>
</tr>
<tr>
<td>73-315</td>
<td>Market Design</td>
<td>9</td>
</tr>
<tr>
<td>73-440</td>
<td>Auctions and Markets</td>
<td>9</td>
</tr>
<tr>
<td>73-474</td>
<td>The Economics of Ideas: Growth, Innovation and Intellectual Property</td>
<td>9</td>
</tr>
</tbody>
</table>

This is not an exhaustive list of qualifying courses. In particular, the graduate courses from Heinz College, Human Computer Interaction, Information Networking Institute, and Institute for Software Research which are open to the Minor in Innovation, Economics, and Entrepreneurship students are not presented. The complete list of eligible may be found on the Undergraduate Economics Program website.

Academic Standards and Policies

Undergraduate economics students are in the unique position of belonging to two CMU colleges, Marianna Brown Dietrich College of Humanities and Social Sciences and the Tepper School of Business. To find a detailed description of policies governing economics students, please consult the Undergraduate Economics Program’s handbook.

Faculty

LAURENCE ALES, Assistant Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2008–.

KATHARINE ANDERSON, Assistant Professor of Economics and Entrepreneurship – Ph.D., University of Michigan; Carnegie Mellon, 2010–.

STEPHEN M. CALABRESE, Visiting Associate Professor of Economics, Carnegie Mellon University-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

KAREN B. CLAY, Associate Professor of Economics and Public Policy, H. J. Heinz III College – Ph.D., Stanford University; Carnegie Mellon, 1998–.

ROBERT M. DAMMON, Associate Dean, Education; Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1984–.

TIMOTHY P. DERDENGER, Assistant Professor of Economics and Strategy – Ph.D., University of Southern California; Carnegie Mellon, 2009–.

KENNETH B. DUNN, Dean; Professor of Financial Economics – Ph.D., Purdue University; Carnegie Mellon, 1979–.

DENNIS N. EPSTEIN, Thomas Lord Professor of Economics; Head, Economics Programs – Ph.D., Princeton University; Carnegie Mellon, 1974–.

MARTA FERREYRA, Associate Professor of Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 2002–.

CHRISTINA FONG, Senior Research Scientist in Social and Decision Sciences, College of Humanities and Social Sciences – Ph.D., University of Massachusetts; Carnegie Mellon, 2001–.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy, H. J. Heinz III College – Ph.D., Northwestern University; Carnegie Mellon, 1995–.

MARVIN GOODFRIEND, Professor of Economics; Chairman, The Henry J. Guaitii Center for Public Policy – Ph.D., Brown University; Carnegie Mellon, 2005–.

RICHARD C. GREEN, Richard M. and Margaret S. Cyert Chair; Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1982–.

JOACHIM RYOHEI GROEGER, Assistant Professor of Economics – Ph.D., London School of Economics; Carnegie Mellon, 2010–.

ISA E. HARFIL, Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.

BURTON HOLLIFIELD, Professor of Financial Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999–.

KARAM KANG, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Pennsylvania; Carnegie Mellon, 2012–.

ONUR KESTEN, Associate Professor of Economics – Ph.D., University of Rochester; Carnegie Mellon, 2005–.

STEVEN KLEPPER, Arthur Arton Hamschlag Professor of Economics and Social Sciences, Social and Decision Sciences, College of Humanities and Social Sciences and Joint Appointment at Tepper School of Business – Ph.D., Cornell University; Carnegie Mellon, 1980–.

YAROSLAV KRYUKOV, Assistant Professor of Economics – Ph.D., Northwestern University; Carnegie Mellon, 2008–.


LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics; University Professor; Director, Green Design Institute; Co-Director, Carnegie Mellon Electricity Industry Center – Ph.D., Harvard University; Carnegie Mellon, 1963–.

REBECCA LESSEM, Assistant Professor of Economics – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–.

BENNET T. MCALMANN, H. J. Heinz Professor of Economics – Ph.D., Rice University; Carnegie Mellon, 1981–.

ALLAN H. MELTZER, The Allan H. Meltzer University Professor of Political Economy – Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957–.


CHRISTOPHER SLEET, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

FALLAW B. SOWELL, Associate Professor of Economics – Ph.D., Duke University; Carnegie Mellon, 1988–.

CHESTER S. SMITT, Pamela R. and Kenneth B. Dunn Professor of Finance; Director, Center for Financial Markets – Ph.D., University of Pennsylvania; Carnegie Mellon, 1979–.

STEPHEN E. SPEAR, Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1982–.

CHRISTOPHER I. TELMER, Associate Professor of Financial Economics – Ph.D., Queen’s University (Canada); Carnegie Mellon, 1992–.

SEVIN YELTEKIN, Associate Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–.

MEHMET B. YENMEZ, Assistant Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2010–.

ARIEL ZETLIN-JONES, Assistant Professor of Economics – Ph.D. (Expected 2012), University of Minnesota; Carnegie Mellon, 2012–.

Visiting Faculty

ANNELEIS DEUSS, Visiting Assistant Professor of Economics – Ph.D., Cornell University; Carnegie Mellon, 2010–.

Adjunct Faculty

CAROL B. GOLDBURG, Director, Undergraduate Economics Program; Adjunct Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–.

ELIF INCEKARA HAFALIR, Adjunct Assistant Professor of Economics – Ph.D., Pennsylvania State University; Carnegie Mellon, 2007–.

FREDERICK H. RUETER, Adjunct Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1998–.
Academic Standards and Actions

In general (allowing that since the CMUQ majors are drawn from four different colleges on the Pittsburgh campus implies some reconciliation is necessary), the same academic standards and actions apply to all programs at CMUQ as at the Pittsburgh campus.

Academic Actions

Students carrying either a full-time course load (defined as 36 or more units) or a part-time course load (defined as fewer than 36 units) are subject to academic actions.

Dean’s List

Students earn Dean’s List recognition in a given semester by achieving one of two minimum standards. They must either earn a semester GPA of 3.75 or higher (while taking at least 36 factorable units and receiving no Incompletes) or earn a semester GPA of 3.50 or higher (while taking at least 45 factorable units and receiving no Incompletes).

Other Actions

Students (other than those in their freshman year) are subject to academic actions if they fail to make minimum progress toward their degree. Minimum progress is achieving a semester GPA of at least 2.0. Students who begin a semester enrolled in 36 or more factorable units and later drop below 36 units are subject to academic actions regardless of their semester GPA.

Freshman students are not subject to academic actions unless their semester GPA is below 1.75.

Probation

Probation occurs when a student’s semester record fails to meet the minimum standards described above. Students are removed from probation if they complete at least 36 factorable units and raise their cumulative post-freshman GPA above 2.00. The school may continue a student’s probation if the student’s cumulative record does not meet minimum standards but his or her semester record suggests that the student may do so by the end of the next semester.

Suspension

If a student fails to meet the minimum standards described above at the end of the probation semester, the student will be suspended. Suspension is for a minimum of one year and the student is required to follow University procedures for departing from campus. At the end of the year, the student may petition to return to Carnegie Mellon by completing the following steps: ask the Assistant Dean for Academic Affairs in writing for permission to resume their studies; submit a completed Return from Leave of Absence Form to the registrar. Provide transcripts for any courses taken at other colleges or universities during the suspension even though academic credits earned during a suspension do not transfer back to Carnegie Mellon.

To get approval to resume their studies the student must demonstrate that they are better prepared to perform above the minimum standards for graduation than before they were suspended. Students coming back from suspension return on probation in the semester of their return.

Drop

A student that fails to meet minimum standards at any point after returning from a suspension is subject to a drop action. A drop action is a permanent severance; the student is required to follow University procedures for departing from campus and may not enroll again in the future. For a poor-performing student, the typical progression of academic actions is Probation, Suspension, then Drop but the intent of the academic actions are to take measures that are in the student’s best interest and therefore the school may bypass one or more of these steps in an unusual case.

Other Regulations Affecting Student Status

Prerequisites and Waitlists

All students registered for a class will have matched the course reservations and completed any course prerequisites for that class. A student that is unable to register and has questions about reservations or prerequisites should see Sheila Rian in office C1174.

Any student on the waitlist for a class that has questions about their ability to eventually enter the class should see Sheila Rian in office C1174. She will determine why they are not on the roster and if she can add them to the class. Students come off wait lists based on the order they went on and any course priority. The course instructor does not determine who comes off the waitlist.

Priority order for coming off of the waitlist is as follows:

1. Students for whom the course is required in their major
2. Students approved for a minor that requires the course
3. Seniority

Adding a Class

Students may add classes to their schedule under the following rules:

1. Students may only add a full semester course through the first 10 class days of the semester.
2. They may only add half semester mini courses through the first 5 class days of the course.

Withdrawing from Courses

CMUQ follows the Carnegie Mellon policies on withdrawing from courses:

1. Students who wish to withdraw from a course without receiving a “W” grade must do so before the published CMUQ deadline. After that date, students may withdraw from a course up to the last day of classes and receive a “W” as a grade for it. After the last day of classes student may not withdraw from a class.
2. A student carrying a full-time course load (defined as at least 36 factorable units) as of the last day to add (10th class day) may not drop below 36 units after that time.

Course Repeats

When a course is repeated, all grades will be recorded on the official academic transcript and will be calculated in the student’s GPA. This is the case regardless if the first grade for the course is a passing or failing grade, including Pass/Fail.

Undergraduate students who wish to repeat a course already passed must obtain approval from the Assistant Dean for Academic Affairs. When a student takes a course s/he has already passed, only one set of units will count towards graduation requirements.

Double-Counting Courses

“Double-counting” refers to instances when a course taken to fulfill one requirement counts simultaneously toward a requirement in another major or minor program. An additional major must be based on at least nine independent courses, excluding prerequisites, and a minor based on at least
five independent courses ("independent courses" are courses not counted toward core requirements for a major or other minor).

Course Overloads
A CMUQ student must have attained a QPA of at least 3.00 in the previous semester to carry an overload (defined as more than 51 units) of up to 62 units. A student wishing to pursue a greater number of units must petition to do so.

Independent Studies
Students may not register an independent study for courses that are normally available at Carnegie Mellon. Exceptions may be approved by the Assistant Dean for Academic Affairs if courses are unavailable or legitimate schedule conflicts seriously hinder completion of degree requirements within four years of matriculation.

Non-Carnegie Mellon Courses
Carnegie Mellon University offers students the opportunity to take courses for credit through a cross-registration program and through the receipt of transfer credit from other accredited institutions. The Carnegie Mellon transcript will include information on such courses as follows:

- Carnegie Mellon courses and courses taken through the university’s cross-registration program will have grades recorded on the transcript and be factored into the QPA. All other courses will be recorded on this transcript indicating where the course was taken, but without a grade. Such courses will not be taken into account for academic actions, honors or QPA calculations. (Note: Suspended students may take courses elsewhere; however, they may not receive transfer credit.)

Definitions
- A Carnegie Mellon course is one conducted under Carnegie Mellon regulations regarding course content and grading and taught by faculty under the supervision of a Carnegie Mellon academic unit. Courses taught by Carnegie Mellon faculty on the Carnegie Mellon campus qualify. Courses that are part of the regular offerings of other universities do not qualify, unless faculty at the other universities receive appointments at Carnegie Mellon and handle Carnegie Mellon students under Carnegie Mellon academic regulations.
- Courses offered for cross-registration are those taken through an agreement with Texas A&M University at Qatar; Georgetown School of Foreign Service in Qatar; Northwestern University in Qatar; Virginia Commonwealth University in Qatar; and Weill Cornell Medical College in Qatar that full-time students at Carnegie Mellon University in Qatar can take up to one class a semester at their schools. Cross-registration requires the completion of a cross-registration form with the appropriate signatures from the home and host institutions. Completion of the form does not guarantee a space in the requested course. The agreement only applies during the regular academic year, normal course transfer rules apply in the summer.

Students may receive credit for courses taken outside of Carnegie Mellon if they successfully petition the Assistant Dean for Academic Affairs in advance for permission. Students must take these courses for a letter grade and instruction must be in English for non-language courses. Credit (but not the grade) will transfer for courses with a grade equivalent to at least a "C" at some institution and at least a "B" at others as determined by the Assistant Dean for Academic Affairs. It is difficult to get transfer credit approval for Business Administration, Computer Science, Economics, Information Systems, and Mathematics/Statistics core classes. The class’s course description must be a close match to the Carnegie Mellon course and from an acceptable four-year institution. Students may take breadth and elective courses at a broader range of schools including two and three year institutions as long as the course is equivalent to a similar offering at Carnegie Mellon. Students may not receive credit for any courses taken online.

Students may not receive credit for more than five non-CMU courses during their undergraduate career as a Carnegie Mellon student. Classes taken prior to enrolling in Carnegie Mellon, during study abroad semesters, and as cross registration with other education City schools do not count toward the credit transfer limit. All students must meet the University’s residency requirement of completing at least 180 units of Carnegie Mellon coursework.

Transferring
Between majors in Qatar
Students may transfer between majors at CMUQ on a space available and academic performance basis. Students interested in transferring should consult with the Assistant dean for Academic Affairs. First year students may not apply for transfer until they receive their spring mid-semester grades.

In Same Major between Qatar and Pittsburgh campuses
CMUQ and Pittsburgh students wishing to transfer between campuses but within their majors should consult with their home Academic Dean. Students are not eligible to apply for transfer between campuses until they meet the following conditions. BA students must have completed 70-208, Biology students 03-231, CS students 15-210, and IS students 67-272. Success of the application depends on the student’s academic performance and the space available in the major on the campus they wish to join. Transfers between campuses are subject to the approval of the Academic Dean for the program on the campus that the student is seeking to join.

Transferring to Pittsburgh in majors not offered in Qatar
Students seeking to transfer to the Pittsburgh campus into a different major do so through the normal processed established by those departments.

Transfers to Qatar from other Universities
Transfer students from other universities must apply through the Carnegie Mellon in Qatar Admission office. If the admission office finds the applicant admissible, they forward the application to the Assistant dean for Academic Affairs who then determines if there is space available in the program and if the student’s past academic performance warrants admission.

Campus Exchange
CMUQ and Pittsburgh students may study on the other campus for one semester on a space available basis and with the approval of both the home and host departments. Given the capacity limitation on both campuses, exchange between campuses is limited to an excess of two per cohort in any major beyond a balanced exchange. As an example, if two sophomore BA students travel from Doha to Pittsburgh in a fall semester then four sophomore BA students may travel from Pittsburgh to study in Doha that semester. Students from any major are welcome to study for a semester in Qatar but if space limitations apply, students from majors offered in Qatar have priority.

The number of students studying in Pittsburgh and Doha do not have to balance in the summer but space limitations and dual approvals still apply.

University Honors
Students maintaining a 3.5 QPA after seven semesters of full time enrollment or raising their QPA to 3.5 upon completing their graduation requirements graduate with university Honors.

Faculty
AMAL AL-MALKI, Assistant Teaching Professor Carnegie Mellon, 2004–.
ILKER BAYBARS, Dean and George Leland Bach Professor Carnegie Mellon, 1975–.
STEPHEN CALABRESE, Visiting Associate Professor Carnegie Mellon, 2005–.
ILIANO CERVESATO, Associate Teaching Professor Carnegie Mellon, 2006–.
ALEXANDER CHEEK, Visiting Assistant Teaching Professor Carnegie Mellon, 2009–.
EMIN CIVI, Visiting Associate Professor Carnegie Mellon, 2012–.
BENJAMIN COLLIER, Visiting Assistant Professor Carnegie Mellon, 2012–.
YONINA COOPER, Associate Teaching Professor Carnegie Mellon, 2005–.
HASAN DEMIRKOPAN, Assistant Professor Carnegie Mellon, 2005–.
RAMI EL SAMAHY, Assistant Teaching Professor Carnegie Mellon, 2006–.
THOMAS EMERSON, Associate Teaching Professor Carnegie Mellon, 2000–.
JONATHAN FINKEL, Assistant Teaching Professor Carnegie Mellon, 2012–.
DAVIDE FOSSATI, Assistant Teaching Professor Carnegie Mellon, 2010–.
JOHN GASPER, Visiting Assistant Professor Carnegie Mellon, 2010–.
DAVID GIAY, Visiting Assistant Professor Carnegie Mellon, 2009–.
SUSAN HAGAN, Assistant Teaching Professor Carnegie Mellon, 2004–.
MAHER HAKIM, Visiting Associate Teaching Professor Carnegie Mellon, 2012–.
KHALED HARRAS, Assistant Teaching Professor Carnegie Mellon, 2007–.
ERIK HELIN, Special Lecturer Carnegie Mellon, 2006–.
KEN HOVIS, Assistant Teaching Professor Carnegie Mellon, 2011–.
STARLING HUNTER, Visiting Associate Professor Carnegie Mellon, 2007–.
KELLY HUTZELL, Associate Teaching Professor Carnegie Mellon, 2005–.
LUDMILA HYMAN, Assistant Teaching Professor Carnegie Mellon, 2010–.
ZEINAB IBRAHIM, Teaching Professor Carnegie Mellon, 2009–.
VALENTIN ILYIN, Associate Teaching Professor Carnegie Mellon, 2012–.
LANSINE KABA, Visiting Professor Carnegie Mellon, 2009–.
ANDREAS KARATSOLIS, Assistant Teaching Professor Carnegie Mellon, 2008–.
SHAM KEKRE, Associate Professor Carnegie Mellon, 2006–.
DIVAKARAN LIGINLAL, Associate Teaching Professor Carnegie Mellon, 2009–.
SELMA LIMAM MANSAR, Associate Teaching Professor Carnegie Mellon, 2007–.
J PATRICK MCGINNIS, Assistant Teaching Professor Carnegie Mellon, 1999–.
TERRANCE MURPHY, Visiting Professor Carnegie Mellon, 2008–.
KEMAL OFLAZER, Teaching Professor Carnegie Mellon, 2008–.
MARION OLIVER, Associate Teaching Professor Carnegie Mellon, 2004–.
SILVIA PESSOA, Assistant Teaching Professor Carnegie Mellon, 2006–.
DANIEL PHELPS, Assistant Teaching Professor Carnegie Mellon, 2007–.
ETHAN PULLMAN, Librarian Carnegie Mellon, 2012–.
SAQUIB RAZAK, Assistant Teaching Professor Carnegie Mellon, 2008–.
BENJAMIN REILLY, Assistant Professor Carnegie Mellon, 2004–.
DUDLEY REYNOLDS, Associate Teaching Professor Carnegie Mellon, 2007–.
ALEX ROJAS-PENA, Visiting Lecturer Carnegie Mellon, 2007–.
GORDON RULE, Professor Carnegie Mellon, 1996–.
MAJD SAKR, Associate Teaching Professor Carnegie Mellon, 2006–.
THIERRY SANS, Assistant Teaching Professor Carnegie Mellon, 2007–.
PATRICK SILEO, Associate Dean and Associate Teaching Professor Carnegie Mellon, 2000–.
MARK STEHLIK, Associate Dean and Teaching Professor Carnegie Mellon, 1981–.
PETER STUETTGEN, Visiting Associate Professor Carnegie Mellon, 2012–.
MATTHEW SZUDZIK, Assistant Teaching Professor Carnegie Mellon, 2011–.
RAY TSAI, Visiting Professor Carnegie Mellon, 2011–.
STEPHEN VARGO, Assistant Teaching Professor Carnegie Mellon, 1997–.
GEORGE WHITE, Associate Teaching Professor Carnegie Mellon, 2007–.
Course Descriptions
Aerospace Studies-ROTC Courses

31-101 Foundations of the United States Air Force
Fall: 3 units
AS100 is a survey course designed to introduce cadets to the United States Air Force and Air Force Reserve Officer Training Corps. Featured topics include: mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and an introduction to communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-102 Foundations of the United States Air Force
Spring: 3 units
AS100 is a survey course designed to introduce cadets to the United States Air Force and Air Force Reserve Officer Training Corps. Featured topics include: mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and an introduction to communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-105 Air Force Leadership Laboratory
All Semesters
The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-106 Air Force Leadership Laboratory
All Semesters
The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-107 Air Force Leadership Laboratory
All Semesters
The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-108 Air Force Leadership Laboratory
All Semesters
The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-201 The Evolution of Air and Space Power
Fall: 3 units
The AS200 course designed to examine general aspects of air and space power through a historical perspective. Utilizing this perspective, the course covers a time period from the first balloons and dirigibles to the space-age global positioning systems of the Persian Gulf War. Historical examples are provided to extrapolate the development of Air Force capabilities (competencies), and missions (functions) to demonstrate the evolution of what has become today’s USAF air and space power. Furthermore, the course examines several fundamental truths associated with war in the third dimension: e.g. Principles of War and Tenets of Air and Space Power. As a whole, this course provides the cadets with a knowledge level understanding for the general element and employment of air and space power, from an institutional doctrinal and historical perspective. In addition, the students will continue to discuss the importance of the Air Force Core Values with the use of operational examples and historical Air Force leaders and will continue to develop their communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-202 The Evolution of Air and Space Power
Spring: 3 units
The AS200 course designed to examine general aspects of air and space power through a historical perspective. Utilizing this perspective, the course covers a time period from the first balloons and dirigibles to the space-age global positioning systems of the Persian Gulf War. Historical examples are provided to extrapolate the development of Air Force capabilities (competencies), and missions (functions) to demonstrate the evolution of what has become today’s USAF air and space power. Furthermore, the course examines several fundamental truths associated with war in the third dimension: e.g. Principles of War and Tenets of Air and Space Power. As a whole, this course provides the cadets with a knowledge level understanding for the general element and employment of air and space power, from an institutional doctrinal and historical perspective. In addition, the students will continue to discuss the importance of the Air Force Core Values with the use of operational examples and historical Air Force leaders and will continue to develop their communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-301 Air Force Leadership Studies
Fall: 9 units
AS300 is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and the communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences in officer-type activities, giving students the opportunity to apply the leadership and management principles of this course.

31-302 Air Force Leadership Studies
Spring: 9 units
AS300 is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and the communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences in officer-type activities, giving students the opportunity to apply the leadership and management principles of this course.

31-401 National Security Affairs and Preparation for Active Duty
Fall: 9 units
AS400 examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. Special topics of interest focus on the military as a profession, officership, military justice, civilian control of the military, preparation for active duty, and current issues affecting military professionalism. Within this structure, continued emphasis is given to refining communication skills. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.
Architecture Courses

48-025 First Year Seminar: Architecture Edition
3 units

48-095 Spatial Concepts for Non-Architects I
Fall and Spring: 9 units
This course serves as an introduction to the spatial concepts of architecture for students from other disciplines. The course is focused entirely on project design work (this is not an historical survey, technical or lecture course). Projects will explore the design and experience of spatial environments through a series of creative investigations. The first half of the semester will focus on short projects, with each design investigation progressively building upon the previous exploration; these early projects will consist of both individual and group work. The second half of the semester will consist of one long term project to be created individually, incorporating students’ personal theories of architecture. Studio work will be supported by group discussion based upon critical review of student work, readings, slide presentations, videos and films. Students are encouraged to explore their own areas of interest with respect to their work in class. Self-motivation, class attendance and an open mind is mandatory, however, no prior architectural, engineering or artistic experience is required. Students are expected to perform work both inside and outside of class. Students should be prepared to purchase various supplies throughout the course. This course is in partial fulfillment of requirements for an Architecture Minor.

48-100 Architecture Design Studio: Foundation I
Fall: 12 units
This is the first course in the design studio sequence. As such, it establishes the foundation of exploration into the design process and provides the fundamental abilities required to represent the students’ inductive and deductive ideas as it pertains to spatial thinking. The semester is divided into two halves: The first half of the semester is devoted to teaching fundamental skills which involve collaboration, experimentation, working at full size, testing, ecological research and basic architectural fundamentals such as drawing and making as they pertain to small scale design projects. These projects focus on teaching fundamentals such as point, line, plane and volume as well as fundamental drawing skills such as line types, plan, section, elevation, volumetric and analytical drawing. The design process then shifts to projects, which introduce the student to spatial thinking. Students are asked to explore the fundamental issues of space through geometry, spatial definition, spatial transparency, overlap and articulation. These projects are explored in both the studio setting as well as through a woodshop project. By the end of the semester students are given an elementary program, which is to adapt the students’ spatial strategy to a specific landscape environment. By developing a relationship between the spatial enclosure, landscape, and the natural environment, the student is to show a basic understanding in spatial thinking through graphic, mock-up, physical and digital modeling.

48-105 Architecture Design Studio: Foundation II
Spring: 12 units
The spring semester, Methods and Transformations in Space of the first year architecture program extends from experiences in the fall semester. Methods and Transformations in Form. Architecture as a spatial practice is introduced. Design projects evolve from previous studies of structure and volume in plant and landscape paradigms. Systems and sequences previously explored in nature are developed in cultural contexts through a progressive series of projects. Mapping human behavior and studying architectural precedents create spatial temporal experiences and narratives. Architectural and interdisciplinary analyses launch each project as a vehicle for generative design strategies. Fluid connections between drawing (freehand and drafted) and modeling (physical, computer, and wood shop) are continued. The semester is divided into three primary design projects: WOODSHOP. The studios explicit relationship to the woodshop is expanded in this course. ROOM (Private) INTERIOR: This project introduces a group research project of architectural precedents as its analytical catalyst. The study of an interior space focuses the transition from form to that of space. PLACE (Public) BUILDING: This project uses, interdisciplinary, cultural research as its analytical formal catalyst. The study of a public infill building establishes architecture within an urban context and requires ability to create spatial sequences of public / private programmatic function. The process includes freehand drawing, model building, shade and shadow, digital modeling, and drafting. Prerequisite: 48-100.

48-115 Physics for Architects
Spring: 9 units
Physics is a basic science, typically taught by the College of Science. Physics for Architecture was introduced in Spring, 2005 to best address the academic needs of students in the School of Architecture. It is taught as a science course that provides an emphasis on the physics topics most essential to architecture. The course covers units, vectors, motion in 2D and 3D, Newton’s Laws of Motion, Applying Newton’s Laws, work, energy, conservation of energy, momentum, impulse, collisions, rotation, equilibrium, gravitation, periodic motion, fluids, temperature, heat, thermal properties, and the first law of thermodynamics. The course is very similar to those offered by the physics department, but it is modified to place heavier emphasis on those topics pertinent to architecture, specifically: forces, reactions, equilibrium, dynamics, vibration, thermal properties of matter, heat transfer, and insulation.

48-116 Building Physics
All Semesters: 9 units

48-120 Introduction to Digital Media I
Fall: 6 units
IDM is a required course for all first year architecture students. The course introduces students to a wide range of digital methods and concepts available to architects for design, representation, and documentation. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital image editing, vector illustration, HTML coding, and 3D modeling.

48-125 Introduction to Digital Media II
Spring: 6 units
IDM2 is a required course for all first year architecture students. This course is the continuation of IDM. IDM2 introduces students to measured drafting and the process of creating a construction drawing set. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM2 addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming. Prerequisite: 48-120.
48-130 Architectural Drawing I: A Tactile Foundation
Fall: 9 units
Introductory course in a sequence of three drawing courses required by the school of architecture for its professional degree program. It consists of in and out of class exercises in free-hand perspective and general life-drawing. Coursework is built around exercises in the required course text: Drawing and Perceiving, John Willey and Sons. Part 1 focuses on contour, Part 2 on volume, and Part 3 on mass, a structure that parallels, in some respects, the on-going work in 48-100. Part 3 provides a review of the earlier work of the course as well as a direct application to an on-going studio projects. Topics are introduced through figure drawing and lecture demonstrations and subsequently applied to architectural subjects. The approach of each of these parts is based on the work of Kimon Nicholaides as presented in his landmark book, the Natural Way to Draw. Work is submitted in three portfolio submissions of three to four weeks each.

48-135 Architectural Drawing II: Appearance
Spring: 9 units
"Understanding Appearance" builds knowledge of the order of appearance and drawing as a reasoned response to same. Coursework covers three subjects: 1) free-hand and constructed perspective 2) shade and shadow projection, 3) chiaroscuro drawing and color drawing in pastel, each of 3-4 weeks duration. Work of each is submitted in 3 portfolio submissions. Prerequisite: 48-130.

48-200 Architecture Design Studio: Composition
Fall: 18 units
This studio is an introduction to architectural design stressing concept generation and the development of a rich design process to create evocative spatial experiences through architecture. Building on the explorations of form and space in the 1st year, we investigate in greater depth the role that program, context, and the physical "elements of architecture" play in creating meaningful architecture. We seek to understand design principles underlying the buildings of the past and present, from the broadly theoretical and conceptual, to the real implications of tectonics and sustainability, and apply these ideas with intent and significance. We will focus on developing challenging architectural ideas, profound building details, and effective ways of communicating them in order to explore architecture's potential for creating poetic expressions, appropriate shelter, or exalted experiences, as well as its ability to embody ideas and impart meaning to the world around us. Prerequisite: 48-105.

48-205 Architecture Design Studio: Materials
Spring: 18 units
Building on the fall studio, the spring semester is concerned with more in-depth understanding and development of designs for small-scale buildings, now informed by greater knowledge related to materials, fabrication, and the act of construction. Following the "New Materiality" evident in architecture today, and acknowledging the importance of materials and assembly techniques for sustainable design, we seek to explore the aesthetic and experiential meaning of materials (WHY?), and the technical knowledge related to the use of materials and the processes of construction (HOW?). The creative opportunities and design implications of using varied materials, structural systems, fabrication and assembly techniques—both analog and digital—are elaborated, especially as they determine the artistic, conceptual, poetic, creative, spatial, and experiential aspects of architecture. The studio projects, lectures, and the required building study will focus on the application and integration of knowledge acquired in a parallel "Materials & Assembly" course 48-215. Prerequisites: 48-200 and 48-210 Corequisite: 48-215.

48-210 Statics
Fall: 9 units
Topics: Vector mechanics; forces and moments; equilibrium of rigid bodies; reactions; sections and internal forces on free-bodies; analysis of simple beams and trusses; stress and strain; elasticity; bending stress; shear stress; beam design. Material is taken directly from the required texts, presenting the scientific background of each concept together with numerous application examples. Students master the material by completing weekly problem sets. The lectures, text readings, problem sets, and examinations form a consistent treatment of the material. Prerequisites: 33-106 or 48-116.

48-215 Materials and Assembly
Spring: 9 units
The fourth semester of architectural studies at Carnegie Mellon University is concerned with the detailed development and refinement of architectural design as informed by the meaning, aesthetics and techniques related to the usage of materials and the process of construction. This is the fourth lecture course of the technology sequence and focuses on the principles of building construction utilizing contemporary systems. Materials and Assembly, taught in parallel with the design studio and Structures I, allows in-depth exploration of the fundamentals of contemporary construction, while the studio provides a simultaneous setting for the application and synthesis of this knowledge. The materials science content of the course examines construction materials with regard to their process of manufacture, their physical properties, their environmental performance and their methods of selection and specification. The assembly content of this course examines the selection, design, preliminary sizing and methodology of construction systems in wood, masonry, steel, sitelcast concrete and precast concrete. The class introduces the fundamentals of enclosure systems. Prerequisites: 12-235 or 48-210.

48-217 Structures
Spring: 9 units
Structures is a required course taught in the second year. It is a successor course to Statics, complementing that previous course by emphasizing structural member design in wood, steel, and reinforced concrete; spatial synthesis of hierarchical one-way systems for gravity load; structural types for lateral load including braced frames, shear walls, and rigid frames; introduction to geometric structures such as cable nets, domes, shells, and air-supported structures. Prerequisites: 12-207 or 48-210.

48-240 Historical Survey of World Architecture and Urbanism I
Fall: 9 units
Reflecting the inseparable relation between building and human needs, this lecture course is not only a history of architecture, but also a history through architecture. This course examines architectural and urban design as a form of cultural expression unique to its time and place. The design, use, meaning and legacy of a building is conditioned not only by the architect’s will or the patron’s desire, but also by a web of technological, religious, social, cultural, economic, and political factors of the time. This course cuts a broad swath through time, geography and cultures, surveying critical episodes in the built environment of Europe, the Middle East, Asia, and the Americas from ancient to present times. This foundation course is the first in the architectural history sequence, and introduces students to the subject and skills of world architectural history. It is a prerequisite for all subsequent architectural history courses.

48-241 Survey of Architectural History II
All Semesters: 9 units

48-300 Architecture Design Studio: Environment
Fall: 18 units
Design Studio III: Building and Site is a required course taught in the third year. The subjects of the Third Year Fall Semester are the reciprocal orders of buildings and landscapes and the development of the building site. The work builds on knowledge gained in prerequisite and co-requisite courses including 48-312 Site Engineering. This course asks students to continue their investigations into the formal and spatial composition and enquires of previous semesters with a focus on the following concepts: Occupancy: Social and cultural phenomena, dimension/measurement and cycles of time relating to human and non-human occupancy Site assessment: site inventory at many scales Grading and surface manipulation: compatibility of grading with related technical considerations for water management, ground structures, surfacing, plants, and maintenance Road alignment: design of roads and parking to support construction, service and the anticipated occupancies, design of roads to connect to other roads with appropriate sight lines, stack spaces, and turning requirements, layout and sizing of parking spaces for vehicles Stormwater: volume and direction of runoff water on both the undisturbed and developed areas, storm water surface system, Plants: selection of plants and plant communities with consideration for regional, local, and site-specific factors Prerequisites: 48-205 and 48-217.
48-305 Architecture Design Studio: Advanced Construction
Spring: 18 units
The basis for the CMU studio course sequence is the expectation that the student retains and applies knowledge gained each semester to the current studio. The spring semester of the third year of architectural studies at Carnegie Mellon University is concerned with the detailed development and refinement of an architectural design as informed by the technical knowledge of structural systems, enclosure systems and the process of construction. The student is expected to articulate concepts and develop designs with more precision and in greater detail than done in previous studios and courses. In addition to criteria related to the development of design skills appropriate to one’s sixth semester of the studio sequence, the following criteria are an explicit part of the evaluation of the student work:
- Aesthetics: The degree to which the design responds to formal issues as articulated in prior design studios.
- Structural System: The degree to which the proposed building is presented as a statically stable structure which defines the spatial order and satisfies the architectural intentions made explicit in the project.
- Enclosure System: The degree to which the proposed enclosure system satisfies the design requirements and responds to the physical phenomena of the environment into which it is placed.
- Material Selection: The degree to which the selected building materials and their implementation are appropriate to the occupancy, articulate the architectural order, and satisfy the physical design requirements.
- Constructability: The degree to which the proposed building is developed in response to an understanding of the processes of construction. Presentation: The clarity, craft and completeness of the presentation.
Prerequisites: 48-300 and 48-312.

48-312 Site Engineering and Foundations
Fall: 6 units
Site Engineering and Foundations is a required course taught in the third year. It is a companion course to the Site Studio (48-300) and covers materials related to the issues of surface and its manipulation (grading, road alignment and stormwater), soils (fundamentals of soil mechanics) and structures (fundamentals of foundation design). Students are introduced to the conceptual fundamentals, exposed to applications in the field, and develop skills which are demonstrated in this class and in their studio work. The course syllabus is broader than found in any existing text treatment, but is supported by one required textbook, two recommended texts and excerpts from other sources.
Prerequisite: 48-217.

48-315 Environment I: Climate & Energy
Fall: 9 units
Environmental Systems is a required course taught in the third year. This course introduces architectural design responses for energy conservation, human comfort, and the site-specific dynamics of climate. Students are expected to combine an understanding of the basic laws of comfort and heat flow with the variables of local climate to create regionally appropriate energy design guidelines for their design projects. The state of the art in building energy conservation and passive heating and cooling technologies, as well as the emerging field of sustainable design are presented, with take-home readings and assignments.
To stress the significance of architectural design decision making on energy consumption and comfort, full design specifications and hand calculations are completed individually by each student for a residential-scale building. Students compile a professional energy consultant’s report, designing the most viable energy conservation retrofit measures for their client from: siting, massing, organization, enclosure detailing, opening control, to passive system integration and management. An overview of world energy consumption in buildings and energy design standards is challenged by lectures on building energy conservation successes and competitive challenges of sustainability. The course ends with a focus on the design integration of natural conditioning systems and the potentially dynamic interface of mechanical systems in small- and large-scale buildings.
Prerequisites: 33-106 and 48-116.

48-332 Architecture Explorations: Teaching and Learning
Intermittent: 6 units
In this course, students will learn about effective strategies for teaching architecture and the built environment. Topics include the cognitive differences between novices and experts, instructional techniques, and goal alignment. As part of the coursework, each student will implement these teaching strategies to design and teach a lesson. Elements of developmental psychology, learning theories, and classroom practices will inform the architectural education lesson plans. Teaching techniques can be generalized for communication with clients, practice, and the community.

48-338 European Cities in the XIX Century: Planning, Architecture, Preservation
All Semesters: 9 units
The history of the main cities of Europe during the XIX century is a history of change and transformation. The physical environment and the political, financial and administrative structures adapt to the needs of new masses of population and to the challenges of metropolitan life. In some cases, cities even acquire new representative functions, as they become a national capital. This course traditionally offers an overview of the urban culture of XIX century Europe, reconstructing aspects of the broader historical context and then focusing on reading the effects of the XIX century transformations on the physical appearance, structures and image of present-day European cities, such as Paris, London, Berlin, Barcelona, Vienna and Rome. This semester we will add to this analysis, acquired by learning and applying a set of essential questions about XIX century urban transformations, a second look at the image of the city - the issue of how the city is represented and described in the various moments of its Nineteenth century transformation (from historical maps, to paintings, from postcards to literary descriptions). We will try to consider its changing visual representation and the different perception of its character and peculiarities over time, finally discussing how the Nineteenth century image of each city still affects how it is viewed today. We will rely, along with the usual reading materials (articles, book excerpts) also on visual documentation, such as photography and film. The course is based on lectures and discussions and requires personal elaboration, as well as a fair amount of reading and writing.
Prerequisite: 48-240.

48-340 Modern Architecture and Theory 1900-1945
Intermittent: 9 units
This architectural history lecture course surveys the modern buildings and literature of the first half of the twentieth century, focusing primarily on Europe but extending also to non-western countries. We begin with a look at the “crisis of modernity” that plagued most of western civilization in the late 19th-century, and then focus on the major movements of both the avant-garde and other responses to modernity from 1900-1945. The course includes lectures, readings, and discussions about a broad range of issues, including: 1) Formal tendencies; 2) Theoretical issues; 3) National traditions; 4) Biographical sketches; 5) Significant technologies and materials; 6) Political motivations; 7) Social & cultural influences. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created, especially the important manifestoes, theoretical and critical writings that so determined the project of modern architecture. Work for the course involves extensive reading and a major research paper.
Prerequisite: 48-240.

48-341 History of Architectural Theory
Intermittent: 9 units
Architecture is not only building, technology, drawings, etc., but also discourse, meaning, communication, and concept: or theory. This architectural history seminar will study in roughly chronological order some of the major theories and theoretics of architecture, from Vitruvius through the Renaissance, the Enlightenment, the 19th-century, up to the modern era. Throughout the seminar we will chart the changing definitions of what constitutes “theory” in architecture, and how it relates to other writings such as criticism and history. We’ll study in-depth how (if at all) the individual theory relates to the intellectual context and built works before and after. Students will discover how ideas reoccur, and even the oldest theories have contemporary relevance. The seminar will culminate with presentations by students on post-war (1945-75) theories of architecture. Work for the seminar will involve extensive readings, active class discussions, and a “report” on post-war theory.
Prerequisite: 48-240.

48-343 American Built Environment Since 1860
Intermittent: 9 units
The American built environment of today is dominated by the city and the suburb. Although cities and homes are hardly 19th century inventions, the landscape we inherit today is deeply affected by the architectural and cultural practices of the preceding centuries. In this course we will study a century of radical change in American architecture, ranging from the rise of skyscrapers to the sprawl of suburbia. We will look at architecture as both a designed object and as a cultural landscape shaped by class, gender, race, economics, politics, and fashion. Through the use of field trips, we will use Pittsburgh as a touchstone for understanding broader cultural and historical themes.
Prerequisite: 48-240.
48-344 Architecture of Henry Hornbostel
Intermittent: 9 units
This course addresses the architectural career of Henry Hornbostel (1867-1961) from the beginning of his architectural education at Columbia University in the late 1880s though his retirement from the profession in 1939 until the revival of interest in his work in the 1980s. Hornbostel studied at the Ecole des Beaux-Arts in Paris, which is reflected in his early work. Later designs incorporate the abstracting tendencies of the Streamline Moderne or Art Deco. Throughout his career, Hornbostel was consistently innovative, eclectic and not necessarily easy to classify, even though the Beaux-Arts label provides an easy way to pigeonhole some of his work. Interest in Hornbostel often begins with his buildings on campus. Many consider the CFA building Hornbostel's masterpiece. Nearby, Hornbostel designed the Rodef Shalom Synagogue, the Soldiers' and Sailors' Memorial, the Schenley Apartments, Webster Hall and a number of buildings for the University of Pittsburgh in Oakland alone. Downtown, the City County Building, the Grant Building and the German Evangelical Protestant (now Smithfield United) Church are also prominent elements in his corpus. Not simply a "Pittsburgh architect," Hornbostel enjoyed national prominence in the profession during his career. He consistently won design competitions for prestigious commissions throughout the country in New York, Ohio, West Virginia, Georgia, Illinois and California. Hornbostel died in 1961, Modernism’s heyday, so he was largely forgotten. There is only a single monograph on Hornbostel and a comparatively small bibliography of recent publications. The exciting counterbalance to this dearth of secondary literature is the presence of many nearby significant built works and major archives of original drawings and other documents at CMU. These play a role in the course.
Prerequisite: 48-240.

48-345 The Cultural Landscape of Northern Italy: Land, City, Architecture
All Semesters: 9 units
The course proposes to plunge into the richness of the cultural landscape of Northern Italy, to examine through its architecture and its culture the relationship of man with land over time. The layers of different cultural and artistic traditions, superimposed and entwined by the passing of time and the changing of rulers and governments, will be read in the frame of a geographic area that is a work of art as well as a powerful narrative of history and culture. In the historical context of the early modern and modern history of the area, the course will deal as well with some urban case studies: the main focus will be the city of Venice, with its rich and complex history, its peculiar blend of cultural and artistic influences and its power to fascinate and inspire through the centuries artists and craftsman, intellectuals and scholars. As if we were traveling through the region, we will start from the cities and territory that we see today, to learn to unearth the layers of their history, their geographic, economical and cultural connections, and to understand the challenge underlying the need to select and preserve part of this incredibly rich and complex memory.
Prerequisite: 48-240.

48-348 Architectural History of Mexico & Guatemala
Intermittent: 9 units
This course surveys the architecture and urbanism of Mexico and Guatemala during three critical periods of their architectural development: (1) the Pre-Columbian development of Mesoamerica, primarily Maya and Aztec; (2) the Spanish colonial architecture and urbanism of the 16th-18th centuries, and (3) the 20th-century search for an appropriate regional modernism. When the Spanish conquistador Hernán Cortés landed in 1519 in what is now Mexico, he encountered one of the world's largest and most spectacular civilizations. The Aztec empire, however, was only the latest urban civilizations in a Mesoamerican tradition that stretched back more than 2,000 years. The ensuing European architectural and urban imprints can be seen as both a victory of colonialism's political, social, and architectural ideals, and as a fusion combining European practices with indigenous conditions and traditions. Centuries later, as 20th-century Latin Americans grappled with the challenges of industrialization, economic swings, and political and social revolutions, architects, planners, and clients again sought to reconcile competing visions of national and modern identities.
Prerequisite: 48-240.

48-350 Postwar Modern Architecture and Theory
Intermittent: 9 units
This architectural history lecture course surveys the modern buildings and architectural theory of the post-World War II period. It begins with the catastrophic of WWII and the fundamental shifts it caused on the conception of modernism, technology, cities, and geo-politics. It proceeds to investigate themes such as rebuilding and reconstruction, grand modern masters such as Mies, Kahn, and Le Corbusier, the fascination with technology, megastructures and utopian thought, the need for monumentality, meaning, and regional identity, and the dissemination of modernism from corporate America to the third world. It ends with the rupture in modernism associated with the social revolutions and the rise of a post-modern architecture in the late 1960s and early 1970s. The course includes lectures, readings, and discussions to define the unique character of the postwar period, as modernism both reigned supreme, and began to be questioned. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created. Special attention will be devoted throughout the course to the important manifestoes, theoretical and critical writings that so determined the project of modern architecture. Work for the course involves extensive reading, preparing for class discussions, and a major research paper.
Prerequisite: 48-240.

48-351 Human Factors in Architecture
Spring: 9 units
Required course Human Factors is an investigation of what makes buildings tick for people: the internal spaces, transitional spaces, transactional spaces, defensible space, owned space, shared space, public space, and most importantly, occupied space. We move up in scale from the individual and group to the community to consider our designers' biases in how we analyze the human needs, how we judge the quality of space and subsequently, how we apply this knowledge to our own design work. Students develop a research question and test it in field research using observation, interviews and surveys. They draw conclusions about the quality of a space and place and how to improve it. Students should leave this class with the ability to discern a problem, experience in applying their understanding of behavioral settings and the human condition to specific research foci, and the ability to use their knowledge and skills deftly in practice, where time and resources are limited. Assignments will be a mix of individual and group work, with emphasis on the latter. There will be an emphasis on reading relevant literature, field investigations and understanding research methods and collaboration for applications in practice.
Prerequisite: 48-205.

48-352 A History of Preservation: Debate, Theories and Practices
Intermittent: 9 units
This course explores selected episodes of the history of preservation, defining in the historical context the respective fields of conservation theory, restoration practices and preservation policies. A first part of the course will focus on the early history of the debate on heritage conservation, early restoration practices and the underlying progressive creation of administrative structures and official policies regarding preservation and heritage listing, (mainly in Europe, from the French revolution to the First World War). The second part will discuss the main approaches of modern architectural preservation and the broadening of the field of preservation (including urban areas and landscape preservation) and the different sensibilities involved in both decision-making and restoration practices.
Prerequisite: 48-240.

48-355 Perspective
Intermittent: 9 units
Course addresses perspective on the basis of three distinct understandings of perceptual psychology: 1) A Kinesthetic Basis for Perspective, which is built on the drawing pedagogy of Kimon Nicholaides. It aligns with the transactionalist understanding of perception and considers perspective as a partially invented and partly discovered truth. 2) The Order of Appearance, which is built on the early work of the perceptual psychologist, J.J. Gibson, and aligns with the ecological position of Gibson and his followers. It considers perspective as an absolute truth of the visual field. 3) Perspective Imposed, which aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Along the way some use is made of on-going design work for subject material. Work is submitted in 3 portfolio submissions of 5-4 weeks duration each.
Prerequisites: 48-130 and 48-135.
48-356 Color Drawing
Intermittent: 9 units
The course will use three media, pastels, colored pencils and water color to address the representation of architectural space. Early work will focus on interiors; later work will extend into landscapes. Topics covered in each will be, value, color temperature and use of complementary palettes. Work will be submitted in three portfolios of 3-4 weeks duration. Work will consist of in-class exercises and out of class assignments using subjects of the students’ choice. Including in-class work, students should anticipate 9 hours of work per week. Students should anticipate material costs for taking the course of ca. $150.
Prerequisites: 48-130 and 48-135.

48-368 Rediscovering Antiquity: Travelers, Archeologists & Architects in Mediterranean
All Semesters: 9 units
The course proposes a journey in the Mediterranean, with special focus on Greece and Turkey, but also travel through time. In fact ancient cities and archeological sites, from the hills of Troy to the archeological sites of Pergamon and Ephesus, to the cities of Athens and Costantinople/Istambul, will be studied not so much as signs of the important Greek and Roman past of the region, but as the object of late Eighteenth and Nineteenth century rediscovery. The rich vestiges of the mythical past of this region were then brought to light, in the frame of complex and adventurous missions. The eyes of scholars, travelers and artists filtered and transformed the reality of the ancient objects and places, adding to their fascination and vitality and changing the way we perceive this legacy today. At the same time though, a new political agenda, new biases and new aims were connected with the rediscovery. These in turn influenced not only the way the past of the region was explored and the way the finds were studied and exposed, but also the cultural debate in the rest of Europe, with important effects on the architecture of the main European cities.
Prerequisite: 48-240.

48-371 American House and Housing
Intermittent: 9 units
The picture of the “American Dream” has typically included a single-family detached dwelling set within its own suburban yard. However powerful and durable that image is, the history of house and home in America is far more complex. This course examines the development of suburban house and urban housing choices circa 1850-1975. Over the course of the semester we will explore housing styles and types, including private single-family dwellings, public multi-unit housing, rowhouses and apartments. We will also examine the wider physical and cultural settings of American housing choices, including the symbiotic relationship between city and suburb. We will look at domestic architecture as both a designed object and as a cultural landscape shaped by class, gender, race, economics, politics, and fashion. Through the use of occasional field trips we will use Pittsburgh as a touchstone for understanding broader national trends in the design of American housing.
Prerequisite: 48-240.

48-400 Architecture Design Studio: Occupancy
Fall: 18 units
The Occupancy Studio raises a designer’s involvement with human needs, functional and space programming, building planning and schematic design with its focus on the relationship of the building user (owner/client, occupant or visitor) to the built environment. At the crux is how an architect develops the methodology to understand the individual or aggregated occupant and assemble decoded, distilled and articulated criteria for the design of space. Studios may emphasize intellectual or theoretical approaches to user-based design, in-depth study of client needs resulting in a detailed program, or participatory design with a real or surrogate client such as a community group. Each semester offers a range of such ideas. Studio faculty varies building typology, conceptual approach, programming studies or development and historical precedent. Studios share information and project knowledge with each other. This healthy mix enlivens design process and class participation. An important aspect of the Occupancy studio and the following Systems Integration studio is understanding the application of codes and zoning requirements, which students research themselves after attending lectures on the basics of life safety, egress and the intrinsic order of code applications. Students are encouraged to work both in teams and as individuals.
Prerequisite: 48-305.

48-405 Architecture Design Studio: Systems Integration
Spring: 18 units
In today’s climate of complex clients and large-scale architecture, design students research and discuss broad political, economic, infrastructure, management and operational systems. Following this theme and in the students’ quest of building integration, they examine the complex interrelationships between performance criteria, building subsystems and their integration, specification, and evaluation. This studio is concerned with the detailed design development relating to the spatial, visual, acoustic and thermal performance of complex buildings as well as the long-term integrity of the integrated systems. Students achieve design integration of at least two building systems and their interdisciplinary objectives - structure, enclosure, interior, mechanical, communications and information, and the safety systems—addressing issues of constructability and technical innovation while combined with suitability to the user, studied in the previous semester of Occupancy.
Prerequisites: 48-400 and 48-412
Corequisite: 48-415.

48-410 Environment II: Light
Fall: 6 units
This course introduces fundamental lighting principles in the context of performance-based architectural design and diagnostics. The course will cover relevant aspects of building physics that affect the physiological and psychological experience of buildings, performance metrics, design and benchmarking methods, and contemporary simulation tools. Topics include a review of physiological and psychological response to the visual environment, analytical and numeric methods for the prediction of lighting conditions in interior spaces, lighting engineering and design methods, and application of computer-aided lighting simulation tools in architectural design.
Prerequisites: 33-106 or 48-115.

48-412 Environment II: Mechanical Systems
Fall: 9 units
Mechanical Equipment is a study of the mechanical systems required to heat, cool, ventilate, wire and plumb a building. Students will focus on energy usage and savings for buildings along with a look at the various system types and equipment used - past, present, and future. The course parallels the AIA review class for the professional license examination, and should become a future study guide for the exam.
Prerequisite: 48-105.

48-413 Building Acoustics
Fall: 6 units
This course introduces theoretical foundations, computational approaches, and design methods in architectural acoustics (building and room acoustics). This course introduces fundamental lighting principles in the context of performance-based architectural design and diagnostics. The course will cover relevant aspects of building physics that affect the physiological and psychological experience of buildings, performance metrics, design and benchmarking methods, and contemporary simulation tools. Topics include a review of physiological and psychological response to the visual environment, analytical and numeric methods for the prediction of lighting conditions in interior spaces, lighting engineering and design methods, and application of computer-aided lighting simulation tools in architectural design.
Prerequisites: 33-106 or 48-115.

48-415 Advanced Building Systems
Spring: 6 units
Advanced Building Systems is a required course taught in the fourth year with a direct connection to the studios emphasizing system integrations. This course introduces the concept of Total Building Performance, delineating the full range of performance mandates required for today’s architecture, including building integrity. Advanced Building Systems highlights the state-of-the-art and major challenges and innovations in building technologies for structure, enclosure, mechanical, telecommunications, lighting, and interior systems. The course explores the relationships, opportunities, and conflicts of the performance mandates, and the integration of building systems necessary to achieve total building performance.
Prerequisite: 48-305.
48-420 City as Landscape: Geography as Method and Metaphor
Intermittent: 9 units
This design theory seminar will explore the emergence of landscape, ecology, and infrastructure as new conceptual, aesthetic and methodological organizers for architectural and urban form. Over the first decade of the twenty-first century it has become clear that the form of urban settlement is driven by complex interacting systems; ecologies and economies resulting in a physical form that has surpassed our traditional notions of “city” or “landscape,” while producing highly unsustainable patterns of development with both ecological and cultural impacts. At the same time contemporary culture has evolved into a hyper-mediated, networked and globalized state which appears increasing unstable, creating both positive negative potentials. During this period the design professions have successfully integrated sustainability at the scale of buildings and products, however, the question of how to best do this at the urban scale remains open for debate. For those working at the scale of the city, one of the most promising recent attempts to reformulate design has been the conceptual merging of landscape and urbanism in to a hybrid practice of landscape, infrastructural or ecological urbanism. Many have argued that landscape architecture, with its emphasis on processes, surfaces, frameworks and ecologies, is better suited to understanding and intervening in the contemporary urban condition. At the same time, much contemporary architecture has explored notions of surface, performance and flexibility, exploring the idea of building as landscape. Both of these approaches have drawn on analytical tools from sources such as geography and ecology to understand spatial and cultural flows. Prerequisite: 48-240.

48-431 Bio Logic Responsive Building Technology
Intermittent: 9 units
The intent of this course is to transfer knowledge from biology and ecology to the field of architecture and thereby better understand the porous boundaries between living and non-living systems. Through the lens of responsive material sets and digital fabrication technologies, students work in multidisciplinary teams to develop responsive building technologies that operate in accordance with the biologic condition of homeostasis: the ability for an organism to maintain equilibrium in response to fluctuating environmental conditions. The outcomes are working models that demonstrate responsive behavior to environmental fluctuations. Once groups are formed, I work with each team to structure a design-research project based on their skill sets. The course is a creative and intensive open-source collaborative workshop where models are constructed and tested during class time. Open to students of any discipline, no previous design experience is required, simply a sustained commitment to transferring your knowledge stream to the design of the built environment. Please contact me if you are curious to see if your skill sets apply. dalec@cmu.edu.

48-440 American Regionalism
Intermittent: 9 units
Despite the leveling forces of mass culture and globalization, the geographic and social diversity of the U.S. has created distinctive regional mosaics of landscape and architecture. Say “New England” and images of English Pilgrims, town greens with white framed churches, and industrial mill villages may come to mind. “The Southwest” conjures different images, perhaps of adobe pueblos, Spanish friars, and ranches, and the color turquoise. The built environment of the Midwest, the California coast, the Mississippi Delta, and many places in between reflect particular regional identities that have been both unconsciously and consciously created over time. This course examines the historical development of regional patterns in the American built environment. It investigates how and why a region’s architectural identity evolved in the ways that it did. To what degree is “place” something to respond to, to interact with, and to what degree is place something that is created? Our focus will be primarily pre-20th century when the forces of vernacular traditions were stronger, we will also examine more recent trends of regionalism as an aesthetic choice and a theoretical stance. Prerequisite: 48-240.

48-441 Frank Lloyd Wright
Intermittent: 9 units
This architectural history course investigates the career and legacy of the famous American architect Frank Lloyd Wright within the context of modern architecture. We will attempt to understand the great variety of work and ideas produced by Wright over seven decades, as well as the context which stimulated and fed off of his designs. We will focus on issues including: 1) Wright’s buildings and projects; 2) the concept of organic architecture; 3) the historical and intellectual climate that gave rise to FLW’s work, including the work of Richardson and Sullivan, the Shingle Style and International Style, Japanese and European modern architecture; 4) investigations of Wright’s progressive clients, innovative use of building materials, changing design theories, invented building systems, radical social & political theories, broad urban experiments, and publishing prowess; 5) the influences Wright had on modern architecture worldwide, especially the tremendous influence he had in America through his own buildings, writings and lectures, as well as some 1200 disciples he trained through his Taliesin Fellowship. Work for the course involves extensive reading and a major research paper. Prerequisite: 48-240.

48-447 History and Preservation
Intermittent: 9 units
This seminar investigates issues in historic preservation from a variety of historical, theoretical, and practical view points. Through intensive reading, class discussion, invited speakers, and field trips, we will explore, discuss, and write about such topics as: the history of historic preservation in Europe and America, preservation philosophies and types of intervention, designating and documenting historic structures, historic house and village museums as preservers and interpreters of history, the relationship between urban renewal and historic preservation, historic preservation as a tool of urban revitalization and cultural tourism, preservation professions. The course is generally organized by a weekly theme, with one class dedicated to discussing the history and theory of a particular aspect of preservation, and the other class dedicated to its actual practice through guest speakers or field trips. Prerequisite: 48-240.

48-448 History of Sustainable Architecture
Intermittent: 9 units
The History of Sustainable Architecture investigates themes of nature, ecology, pollution and conservation in the built environment and visual arts. The term “sustainable architecture” is a comparatively recent one, arising in reaction to the destructive and toxic nature of the industrial era and its strident ambassador, Modern architecture. Yet, an aesthetic and philosophical view of harmony with nature accompanies many forms of historical human activity in the built environment. Similarly, issues of waste removal, mechanical systems and natural materials that characterize current concerns have illustrative historical roots in numerous civilizations going back centuries and even millennia in Pre-Industrial or non-industrial cultures. This course will engage texts and examples relating not simply architecture, landscape and urban history, but also art, philosophy and popular culture as a means to understand the many precedents for today’s interest in sustainable architecture and planning. The course will examine texts and works by figures including Vitruvius, Flimy, Leon Battista Alberti, Thomas Cole, Frederick Law Olmsted, Buckminster Fuller, Reyner Banham, Ebenizer Howard, Hassan Fathy, Bernard Rudofsky, Norman Foster, Robert Smithson, Andy Goldsworthy and more. Students will be encouraged to apply principles from the class to understanding and execution of work in their own discipline. Prerequisite: 48-240.

48-452 Real Estate Design and Development
Fall: 6 units
This course will introduce the Real Estate development process and explore the interdependence of development drivers and the design process. Classroom learning, exercises and guest-lectures will introduce students to the concepts of market and financial analysis, as well as the basic techniques of budgeting, proforma development, and valuation. Parallel to this investigation, students will evaluate real world developments and interface with the development professionals that executed them to learn how development drivers shaped the development process and decision making. Students will study how market demand, tenant requirements, site constraints, and available capital affect feasibility, and through this the ultimate design solution. The semester’s effort culminates in the execution of a mini-development project. Students will work in teams to complete a basic market analysis, program evaluation, schematic design, construction and development cost estimate, proforma analysis, and a determination of financial feasibility. Development practitioners will interface with student teams during this mini-project to offer “real world” guidance on student schematic designs and feasibility analysis. Prerequisite: 48-305 Corequisite: 48-500.
48-453 Urban Design Methods
Fall: 6 units
This undergraduate lecture course introduces urban design history, theory and methods. It is a required supporting course for the Urban Laboratory design studio, and similarly examines urban design at multiple scales: city form and networks, neighborhoods and block structures, streets, public spaces, and urban building typologies. Key issues introduced include the emergence and evolution of urban design as a discipline, economic, social and political factors affecting the contemporary city, and environmental sustainability at the urban scale. A wide variety of cities, projects, proposals and methodologies are examined. Assignments include readings from seminal texts, quizzes, and a final examination. Prerequisite: 48-305 Corequisite: 48-500.

48-470 Exploring Pattern Through Lamination
Fall: 6 units
This course, Experimenting with Lamination, Clamping and Cutting, will review standard shop process and expand upon initial instructions the students have already received. Topics will be demonstrated in class and assignments relating to the demonstrations will be issued. Demonstrations may not take the entire class time in which case the students will work under the instructor's supervision. Multiple assignments will be given throughout the course. Several demonstration topics may be incorporated into one assignment. While assignments are process driven, thoughtful, well crafted execution reflecting good design will be essential. Projects will be idea statements rather than finalized (functional) objects. Each exercise will present a series of basic wood working operations, which, when repeated and recombined will become products of compelling visual character. As visual idea statements you will be asked to experiment, invent and explore and take these standard operations in new directions. Prerequisite: 48-105.

48-473 Hand and Machine Joinery, New Directions
Fall: 6 units
This course, Hand and Machine Joinery, New Directions will be offered in the second half of the semester and, like Experimenting With Lamination, Clamping and Cutting, will be considered fulfillment of the prerequisite for, Furniture Design and Construction. It will distill the broad array of wood joints that have been used in furniture through centuries into a collection appropriate to contemporary woodworking and modern style. The collection will include perpendicular and angled joints with two, three, and more intersecting members. Different methods for interlocking these members will be demonstrated using machine and hand tools. Students will be given assignments which require the adaption of these interlocking methods to different design circumstances. Prerequisite: 48-105.

48-477 Undergraduate Making things Interactive
Intermittent: 9 units
Learn to design and build interactive projects that combine physical form, mechanical behavior, electronic sensing and actuation, and computational control. Making Things Interactive is intended for people with no previous technical background but an appetite for hacking, tinkering, and creative play with materials, transgressing disciplinary boundaries. The first half of the course is a series of short exercises leading to a term project of your choice, carried out in the second half of the semesters. The class has attracted students a cross campus, including both graduate and undergraduates at all levels. It’s a combination of programming, robotics, materials, conceptual design, and construction; and where you take it is up to you. The only firm requirement is that you learn the technical material through the exercises and apply it in a term project. For previous editions, see class blogs at http://mti09spring.wordpress.com/ http://mti08fall.wordpress.com/

48-478 Digital Tooling
All Semesters: 6 units
This course serves as an immersive analysis of the available technologies located in the Digital Fabrication Lab at Carnegie Mellon and beyond. Students begin to understand equipment limits/boundaries, purposes and concepts; and the possibilities that arise from thoroughly comprehending how these tools work. During your Digital Experience, students begin to understand more systematically how to use these tools to their advantage. A better understanding of the equipment proves very useful towards a SoArch Student’s 3rd, 4th and 5th years at Carnegie Mellon; but more importantly provides a fundamental understanding of a leading edge technology that will certainly prove itself as an integral tool for any Designer throughout their professional career. It is based on the idea that pushing the limits of design fabrication; comes from knowing the limits of your tools. The course operates by discovering tooling extremes; thus indicating limits, and then incorporating these boundaries (and/or breaking them) with Digital Fabrication methods and tooling; ultimately providing a platform in which students begin to understand and incorporate project efficiency. Prerequisites: Imagination, Laser Cutting, Milling and 3D-Modeling Experience required. (Rhinoceros 3D Preferred) Prerequisite: 48-205.

48-497 Thesis I
6 units
The Urban Lab studio at Carnegie Mellon seeks to educate architects to be leaders for vision-based change at the scales of neighborhood, city and region. It is intended to both introduce students to urban design and inform their understanding of building design in relation to existing neighborhoods. Our approach to urban design engages the city as an integrated design problem that is best solved through a participatory design process. Each year, teams of students and faculty seek to catalyze the revitalization of Pittsburgh urban neighborhoods by working with Mayors and elected officials, public agencies, private investors, and citizens of communities to collectively envision physical change within their neighborhoods and communities. Without being direct providers of technical assistance for communities, the Urban Laboratory has used the educational qualities of the urban design studio to build long-term university-community partnerships and ultimately build the capacities of communities to be their own drivers of change. Equally important to introducing the participatory process in urban design, the Urban Lab also emphasizes the importance of collaborative, multi-disciplinary design and decision-making. Students expand architectural design skills and gain new skills in urban design, planning and community leadership. In short, the Urban Lab represents the culmination of the architectural educational experience, by expanding existing skill sets, dramatically increasing the scale of intervention, and introducing a real client – the community. Prerequisite: 48-405.

48-505 Architecture Design Studio: Thesis
Spring: 18 units
This project-based thesis studio offers the opportunity for creative understanding, spatial experimentation and architectural consolidation. The thesis is to be enriched by a dynamic process of discovery during the development of the project. The thesis project grows out of this exploration and does not precede it. A well researched, clearly articulated thesis project develops the student’s individual architectural voice. Working from one’s own comprehensive knowledge in architecture to date, theory, humanities, history, cultural criticism, philosophy, music, art, etc., the successful thesis project challenges us to question our convictions about architecture and urban design. The goal of the architectural thesis is to demonstrate such creative understanding and be able to sustain critique at various levels of interpretation, project resolution and inquiry. *Students can also fulfill Studio X via a School of Architecture approved Study Abroad Experience. Prerequisite: 48-105.

48-512 Contemporary Architectural Theory II
Intermittent: 9 units
This is the second course in a sequence on Contemporary Architectural Theory, but the first is not a prerequisite. As a counterpart to the first course which considered philosophical, literary and cultural theory as broader interpretive frameworks, this course will emphasize theoretical texts which document and contextualize the specific conceptual and physical processes of generating space, form, and meaning of contemporary architectural design, in structures whether real or virtual, built or represented. Authors will include but not be limited to Herzog & de Meuron, Toshiko Mori, Kenneth Frampton, Gregg Lynn, Winy Maas, Michael Belz, Zaha Hadid, and Daniel Libeskind. This course will operate as a seminar and depend significantly on student participation in discussions and presentations. It will include a significant section of student-suggested readings.
48-531 Fabricating Customization  
Intermittent: 9 units  
This course will explore the tectonic, material, and organizational opportunities afforded through automated fabrication and assembly. Particular attention will be directed to the opportunities for mass customization at the building component scale. Emergent topics of digital craft, performative architectures and responsive design will be explored in relationship to culture, economy and technology. To this end, focus will move beyond formal novelty to meaningful architectural impact. Specific attention will be focused on robotic fabrication. Given the process / task flexibility inherent with robotics, attention will be paid to a range of processes and scales. Through a series of design and fabrication investigations student groups will develop a comprehensive understanding of the robotic fabrication workflow relating to various digital design processes. The recently acquired 7 axis robotic milling machine and 6 axis robotic gripper will serve as the principal instruments of the exploration; however all tools within the lab will be utilized. In an effort to leverage the equipment available, particular focus will be directed to a critical understanding of the distinctions between analog fabrication, traditional digital fabrication and robotic fabrication. To this end, both additive and subtractive processes will be explored. Technical proficiency and critical engagement of the processes will occur through a structured sequence of fabrication projects. These results will provide a basis to inform student group projects. As an advanced digital fabrication course, students should be proficient with CNC routing and high fidelity digital modeling.  
Prerequisite: 48-125  
Corequisite: 48-400.

48-539 Performance Driven Composite Surfaces  
Intermittent: 9 units  
Through design and fabrication processes that are informed by how various surfaces can perform, students in this class will develop a large scale architectural installation that specifies upon the potential found within combinations of standard materials. The material relationships will provide the framework to transform the traditional assumptions of material and produce hybrids. Particular focus will be devoted to structural, acoustic and visual performance as they relate to the creation of space. The installation from this class will be a collaborative project. As such, all participants will be required to work closely through all stages of the project. Given the design build nature of the class, students should expect to physically produce a significant body of work. This class will rely upon the DFab within the SOA and therefore requires digital modeling proficiency. Students will learn the fundamentals of a select number of CAD/CAM processes but will be expected to build upon these skills outside of the context of formal lectures. Since the SOA will provide a material budget for the class, students should not expect to incur significant material costs.  
Prerequisite: 48-125.

48-550 Issues of Practice  
Fall: 9 units  
Issues of Practice is a required course taught in the fifth year. It consists of three modules: Personal Promotion, Emerging Professional’s Companion, and Excursions. The Personal Promotion module provides the students with a framework to create a resume, cover letter, and portfolio. The EPC (Emerging Professional’s Companion) provides concentrated study in critical aspects of professional practice. The Excursions require students to see how architecture relates to the wider world with architecturally related events that can include volunteer opportunities, lectures, mentorship, or teaching.  
Prerequisite: 48-305.

48-551 Ethics and Decision Making in Architecture  
Spring: 9 units  
Ethical Decision Making in Architecture is a required course in the fifth year of the Bachelor of Architecture Degree. It is part of a sequence dealing with professional aspects of the field of architecture, alongside courses like Human Factors, Real Estate Design and Development, and Issues of Practice. It builds on an understanding of the issues of occupancy, economics and practice in design decision making. The course covers basic frameworks of decision making and ethical adjudication through several case studies including Fallingwater, Sydney Opera House, Citicorp Tower, Pruitt-Igoe housing development, Crystal Palace and Kansas City Hyatt. The text for the course is a manuscript by the instructor entitled "Ethical Decision Making in Architecture".  
Prerequisite: 48-205.

48-564 Furniture Design & Construction  
Spring: 9 units  
The spring elective is for students who want to build furniture of their own design. The instructor will assign the type of furniture to be built. The course is for students with knowledge of basic wood working techniques, the operation of standard woodworking machines, and specifically the array of the machines we have in the SOARCH shop. For this reason there are prerequisites including the first year shop training offered in the "Introduction to Architecture" course and one of the fall mini shop electives. In lieu of the prerequisites the instructor will review photographic documentation of a student’s work which demonstrate comparable experience. The instructor will determine if the projects represent sufficient experience to qualify for the class. One project will be assigned, designed and built during the semester by each student. Exercises relating to design and construction will be assigned as well. Wood will be the primary material, however additional materials may be incorporated. Equipment and procedures beyond those covered in the prerequisites will be introduced as necessary throughout the course. The project deadline, and a review, will be scheduled during the final exam period at a time determined by the class.  
Prerequisites: 48.105, 48.470 OR 48.473  
Prerequisites: 48-105 and 48-470 and 48-473.

48-566 Advanced CAD, BIM, and 3D Visualization  
Fall: 9 units  
This course is designed to introduce a student to advanced software applications, including AutoCAD 3D, 3D Studio MAX, and Autodesk REVIT. Students will learn how to properly set up and manipulate CAD projects integrating all three software applications, replicating real world projects in leading architectural firms. Building information and parametric modeling, animations, materials, lighting, and rendering concepts will allow students to create integrated projects, 3D video animations, and realistic renderings. At the conclusion of this course, students will have projects and animations created and architectural CAD standards outlined. Students should have some familiarity with basic AutoCAD 2D commands. Those who don’t have AutoCAD 2D knowledge can contact the professor to arrange for on-line tutorials that need to be completed before classes begin.  
Prerequisite: 48-305.

48-569 GIS/CAFM  
Prerequisite: 48.105, 48.470 OR 48.473  
Spring: 9 units  
Geographic Information Systems (GIS) are computerized systems designed for the storage, retrieval and analysis of geographically referenced data. GIS uses advanced analytical tools to explore at a scientific level the spatial relationships, patterns, and processes of cultural, biological, demographic, economic, geographic, and physical phenomena. Facilities management is the practice of coordinating the physical workplace with the people and work of the organization. FM integrates the principles of business administration, architecture, and the behavioral & engineering sciences. Computer Aided Facilities Management (CAFM) integrates various tools that demonstrate the use of software in facilities management to streamline operations, boost productivity and develop strategic planning goals for an organization. Application areas covered in this course include city and regional planning, economic development, education, elections, and environmental studies, housing and property evaluation, transit and transportation issues, land use, crime analysis, emergency management, census population and demographic studies, health and business uses, 3D modeling, space planning, asset management, building operations, real property and lease management, and telecommunications.  
Prerequisites: 48-120 and 48-205.

48-576 Mapping Urbanism  
Intermittent: 9 units  
This seminar provides the critical tools necessary to examine the city as both a representation and a reality in flux. Through an interdisciplinary framework, students study urban history, theory, visual thinking and spatial mapping. Weekly lectures introduce world cities and their topologies – e.g. the quintessential city, the shrinking city, the growing city and the megalopolis. Readings, films, presentations, and class discussions focus on global issues and the built environment. Parallel to these urban explorations, students learn to employ a diverse set of representational techniques to create inventive mappings. All upper-level (300 and 400 level undergraduate and graduate) students with working knowledge of Adobe Illustrator and/or InDesign are encouraged to register.
48-577 Contemporary Middle Eastern Cities
Intermittent: 9 units
As the capital of Qatar, Doha is a city on the precipice of immense change. The numerous cranes, the vast infrastructural investments, and the alterations to the natural landscape merely mark the beginning of an enormous nation-wide project that has chosen to focus on education, culture and sports. Amidst our enthusiasm for this progressive policy, the following issues inevitably arise: the environmental impact of rapid urbanization, the changes to the local culture, and the long-term effects on the next generation. These issues will be examined by looking at both cultural context and physical form. Students will investigate the large scale, regional effects of urbanization as well as smaller interventions within a given neighborhood, and will explore interrelations between the two scales. The course includes a field research trip in early September to gather data, document sites, and interview key decision-makers in the fields of planning, architecture, design and education. We will interact with students at Carnegie Mellon’s branch university in Education City, a vast campus of institutions on the city’s edge which figures large in the country’s development and, consequently, in this course. Students will present to their peers their research results and will prepare work intended to culminate in a final project that represents a synthesis of their research. It is expected that students will respond in both writing and drawing, utilizing information design as a means of expressing their findings.

48-579 Middle Eastern Cities: Case Studies from Two Centuries of Urban History
Intermittent: 9 units
The Middle East is home to some of today’s most dynamic metropolitan areas, sharing with growing urban conglomerations in other areas of the world the need to address issues like burgeoning populations, the environmental impact of rapid urbanization, and post-disaster reconstruction, both natural and man-made. At the same time, the history of Middle Eastern cities is a finely woven tangle of cultural specificity and reactions to international models, presenting similar challenges towards preservation of urban fabric, integration of historical buildings in the growing urban body, and choices regarding the visual identity of the city. We will be looking at both cultural context and physical form of the contemporary city, and then apply the methods of urban history to gain deeper understanding of one specific aspect of urban culture. Students will be encouraged to look at large scale, regional effects of urbanization as well as smaller interventions within a given neighborhood, and to search for the interrelation between the two scales, while they consider continuity and change in the historical fabric of the city. The course will examine several of the region’s significant cities in a case study model. Students will present to their peers their research findings for a given city and will prepare work that will culminate in a final project that represents a synthesis of their research. It is expected that students will respond in both writing and drawing, utilizing information design as a means of expressing their findings.

Prerequisite: 48-105.

48-588 Contemporary Architectural Theory I
Intermittent: 9 units
Contemporary Architectural Theory is less of a description than a collection of three contentious terms. Current architectural discourse can search for innovative form or the mechanisms of meaning. More crucially, it can seek critical assessments of political, economic, and environmental forces. It may use the language of philosophy, literary and cultural criticism, economic and political analysis, popular culture or social activism. The purpose of this course is to read from the literature of the numerous methodological and disciplinary approaches that fit under the loose rubric of contemporary architectural theory to develop students’ skills in critical thinking about and clear communication of the complexities of current architectural discourse. Authors will include but not be limited to Jean Baudrillard, Jean-François Lyotard, Michel Foucault, Fredric Jameson, David Harvey, Saskia Sassen, Diane Ghirardo, Keller Easterling, Michael Bell, Sanford Kwinter, Jeffrey Kipnis, Manuel de Landa, Paul Virilio, Sylvia Lavin, and Saskia Sassen. It will include a significant section of student-suggested readings.

Prerequisite: 48-105.

48-595 Under the Influence: Architecture & Art I
Intermittent: 9 units
Under the Influence: Architecture and Art is an elective course taught in the spring semester. Many of the world’s leading architects cite art and cinema and other cross disciplinary factors among their most significant inspirations. Rather than basing their successful architectural practices on narrowly focused foundations, these architects boldly cross borders into the worlds of music, fashion, photography, film, art. New York architects Scorsio & Diller reference Marcel Duchamp, Rem Koolhaas, Herzog & de Meuron design for Prada, Peter Eisenman acknowledges the writings of Robert Morris among other artists, and Bernard Tschumi has based buildings on the editing principles of Sergei Eisenstein. The list goes on. At the same time, many contemporary filmmakers look to architecture for their conceptual framework. Why are these artists and architects looking outside of their disciplines to cross over into each others worlds for inspiration and direction? What are they learning and how are they applying their discoveries? What can we learn from these leading figures and how can we ourselves begin to cross borders to develop new working methods and approaches that will advance our own professional and creative processes? These are some of the questions that the course addresses.

Prerequisite: 48-105.

48-596 LEED Buildings and Green Design
Spring: 6 units
Green building and sustainable design have been rapidly gaining acceptance in all sectors of the building market. Global issues of energy use, emissions, resource depletion, and land use are forcing building professionals to re-evaluate standard design and construction processes, and look to more environmentally friendly practices. The U.S. Green Building Council (USGBC) developed green building rating systems entitled Leadership in Energy and Environmental Design (LEED) in order to define “green building” by establishing a common standard of measurement. LEED considers green building methods and technologies in several categories including site, water, energy, materials, and indoor air quality, and awards points towards an overall green building rating of certified, silver, gold or platinum. Currently, LEED registered projects make up 3% of the current U.S. commercial building market, and Pennsylvania is the third leading state with LEED registered projects. There is now a demand for design professionals with knowledge and experience not only in sustainable design but specifically with the LEED rating system as well. This course will provide students with background knowledge of the USGBC, the LEED system, as well as referenced standards related to specific topics. The course will benefit greatly from the large number of LEED projects in the Pittsburgh region, which will serve as case studies. Upon completion of the course, students will be prepared to take the LEED Professional Accreditation Exam, which is quickly becoming the standard of recognition for green building professionals.

Prerequisite: 48-315.

48-711 Paradigms of Research in Architecture
Fall: 9 units
This course is both an introduction to important models and methods of academic research particularly as they are related to building design issues and a forum for intellectual curiosity. During the initial ten weeks of the semester, the course presents an overview of the field and covers several models of research as they relate to the building design. These will include models of natural sciences, social sciences, sciences of the artificial, engineering and aesthetics in building design. During the final five weeks of the semester faculty both CFA and CIT will be invited to make presentations about their areas of research and the methods they use. These presentations correspond in many respects to those covered in lectures.
48-721 Building Controls and Diagnostics
Intermittent: 12 units
This course introduces the concepts and methods of building diagnostics. It focuses on the empirical evaluation of the built environment (building components and systems, interactions between buildings, occupants and their environmental conditions) in view of multiple performance criteria (thermal, visual and acoustic performance). Field measurement and assessment techniques will be introduced. The empirical methods of building analysis are commonly used to: describe/specify building components; study the real-time behavior of buildings; detect the causes of building failures; and gather data for model validation. The course will address these issues, both theoretically and practically, through the application of: field measurement techniques; physical modeling methods; and computer-aided building modeling. Computer-aided data processing techniques will be applied for the analysis and interpretation of the results of model and field studies. The role of building performance simulation in the area of building diagnostics will be investigated.

48-722 Building Performance Modeling
Fall: 12 units
This course introduces fundamentals and computational methods in building performance modeling. Topics include: modeling and design, overview of thermal, visual, and acoustical domain knowledge, integration of performance simulation in computer-aided design, introduction to the application of advanced computational building simulation tools, case studies and design assignments on the application of simulation in the evaluation and improvement of building performance.

48-723 Performance of Advanced Building Systems
Spring: 9 units
Advanced Building Systems Integration This is a graduate level course that focuses on commercial building performance achieved through systems integration. In lectures, class discussion, and student projects, we will explore the topic of building performance, the design and technical strategies that support sustainable high performance; the design, construction and operation processes that are likely to produce sustainable high(er) performance buildings; and the current state of theory versus practice. The course assumes a basic understanding of building’s impact on the environment, of building design and materials performance, and of the calculation of building heating and cooling loads. On that foundation, we will examine the concept of systems integration and how this approach can sustain the occupants and the environment far better than conventional design, construction and operation. Although US climate, building conventions and codes will be our reference point, we will broaden our discussion by using examples and data from many other countries. An essential aspect of our exploration will be identifying successful built projects and examining the factors that may have allowed these projects to succeed. If this course succeeds, those who successfully complete the material will understand and be able to discuss sustainable building performance characteristics, will understand the systems integration approach and how it differs from conventional approaches to building design, and will be able to develop architectural and engineering decisions to support the design, construction and operation of sustainable high performance buildings. Prerequisite: 33-106.

48-724 Parametric Design
Intermittent: 6 units
This is an introductory course to parametric modeling, which can be taken either as a half-semester assignment-based course, or as a full semester course with a parametric design project component. The course will introduce i) fundamental concepts of geometric modeling including such topics as: spatial coordinates, projections, Boolean operations, formal transformations, freeform surface creation, development and deformation; ii) parametric techniques and tools to model designs parametrically, to construct geometrical relationships among complex shapes, and to deal with constraints and their propagation. The lectures will be on computational geometry that can be applied to architectural design. In addition, the lectures will focus on hands-on techniques that can be applied to the design process, to extend the efficiency and productivity of work during the process. For practical reasons, the course will use Rhinoceros, Grasshopper, Rhinoclip, and .NET framework. Prerequisites: 48-300 and 48-624.

48-725 Real Estate Design and Development
Fall: 9 units
This course will study the real estate development process and explore the interdependence of financial investment drivers and the creation of this built environment. Classroom learning, exercises and guest-lectures will introduce students to the concepts of market, location and valuation, as well as the basic techniques of real estate finance including development budgets, operating proformas, return analysis, and lender requirements. Parallel to this investigation, students will have opportunities to study real world developments and interface with the development professionals that executed them to learn how development drivers shaped the development process and decision-making. The semester's effort culminates in a feasibility study of a development site Pittsburgh. Students will complete a basic market analysis, program evaluation, zoning, deeds, liens and a determination of financial feasibility. Students will study how market demand, tenant requirements, site constraints, and available capital affect feasibility, and through this the ultimate design solution. Development practitioners will interface with student teams during this case study to offer "real world" guidance on student proposals.

48-728 Special Topics in BPD: Redesigning Our Built Environment
Intermittent
The course includes an overview of various real life concepts to implement “Value Added Propositions” for buildings. The goals are to: 1. Provide energy efficient and sustainable designs and processes for existing residential, educational and office buildings. 2. Gain basic understanding of building science, renovation technologies, and techniques used in today’s construction industry. 3. Learn how a scope of work is developed for a Green Building through building diagnostic techniques and energy modeling. 4. Examine energy efficiency financing opportunities. Students will work with industry, manufacturers, and government to help identify the challenges and barriers facing the industry and provide new efficient solutions and strategies.

48-729 Productivity, Health and the Quality of Buildings
Intermittent
Given the growing demand for green buildings by federal and private sector clients, professional practices are “tooling up” all over the world to deliver high performance, environmentally responsive, “green” buildings and communities. However, investments in green, high performance building solutions and technologies are still limited by first cost decision-making, and life cycle tools are still largely inaccessible to professionals. A new building investment decision support tool – BIDS™ - has been developed by the NSF/IUCRC Center for Building Performance at Carnegie Mellon University, with the support of the Advanced Building Systems Integration Consortium. This cost-benefit decision support tool presents the substantial cost-benefits of a range of advanced and innovative building systems designed to deliver – performance, energy efficiency, productivity – that professional practices are “tooling up” all over the world to deliver. Students will look at both the theoretical and practical implications of implementing green buildings through building science, renovation technologies, and techniques used in today’s construction industry. The course will explore the relationship of the built environment to human performance, health, and well-being. The course will engage students in the literature relating building design decisions to ten cost/performance impacts: energy, facilities management, organizational change, technological change, attraction/retention (quality of life) of employees, individual productivity, organizational productivity, salvage/waste, tax/insurance litigation, and health. Instructor(s): Vivian Loftness
Prerequisite: 48-305.

48-739 Making Things Interactive (Graduate)
All Semesters: 12 units
In this hands-on design-build class you will learn the skills to embed sensors and actuators (light, sound, touch, motion, etc.) into everyday things (and places etc.) and to program their interactive behavior using a microcontroller. Through weekly exercises and a term project the class will introduce basic analog electronics and microcontroller programming, as well as exploration into using kinetics and materials to make the things you design perform. Emphasis will be on creating innovative experiences using simple robotic technologies. The graduate edition of this course will require additional work including a paper that can be submitted to a peer-reviewed interaction design conference such as CHI, IUIST, or TEI. Students from all disciplines are welcome: but please note that the class demands that you master technical material. Experience in at least one of: programming, electronics, or physical fabrication is strongly recommended. (Participants will provide their own supplies and materials.).
Discussed to provide a context for studio projects. Of narrative, experimental, performance, documentary and animation a dynamic tool for time-based media production. In this course students Electronic Media Studio One (EMS1) is an introduction to the computer as Spring: 10 units 60-110 Electronic Media Studio I permission. Lecture/discussion format. All students are required to attend the School of Fall: 6 units 60-152 Zero Energy Housing open to freshmen admitted to the School of Art, or by instructor permission. Dozens of “net-zero energy” houses and a few commercial buildings now exist, but they are far from common practice. What does it take, technically, to accomplish this goal and what else, beyond technical requirements, advances or impedes a net zero housing future? 48-752 is a graduate level class that explores, through case studies and applied projects, what it takes to make substantial improvements in residential building energy performance while maintaining occupant comfort and satisfaction. We’ll begin by discussing several definitions of a net-zero building and the implications of each definition. Through case studies, lectures, and outside reading, we’ll explore how a net-zero building is achieved, including the use of renewable energy to achieve the net-zero balance. We’ll apply those ideas to real sites and to new design or renovation projects in Pittsburgh and will use simulation software to test and quantify the impact of our design/ renovation strategies. We’ll also evaluate our strategies against specific US codes, guidelines and standards such as IECC-2009 and LEED for Homes to see how these types of documents move us toward a goal of producing much higher performance buildings. While we will focus on residential buildings, many of the concepts and strategies we cover have parallels in the commercial sector. Students who enroll in the class are expected to build on hands-on techniques that can be applied to the design process, to extend the efficiency and productivity of work during the process. For practical reasons, the course will use Autodesk Revit Architecture 2011, Green Building Studio and .NET framework. Prerequisite: 48-205.

48-752 Zero Energy Housing
Fall: 9 units
Dozens of “net-zero energy” houses and a few commercial buildings now exist, but they are far from common practice. What does it take, technically, to accomplish this goal and what else, beyond technical requirements, advances or impedes a net zero housing future? 48-752 is a graduate level class that explores, through case studies and applied projects, what it takes to make substantial improvements in residential building energy performance while maintaining occupant comfort and satisfaction. We’ll begin by discussing several definitions of a net-zero building and the implications of each definition. Through case studies, lectures, and outside reading, we’ll explore how a net-zero building is achieved, including the use of renewable energy to achieve the net-zero balance. We’ll apply those ideas to real sites and to new design or renovation projects in Pittsburgh and will use simulation software to test and quantify the impact of our design/renovation strategies. We’ll also evaluate our strategies against specific US codes, guidelines and standards such as IECC-2009 and LEED for Homes to see how these types of documents move us toward a goal of producing much higher performance buildings. While we will focus on residential buildings, many of the concepts and strategies we cover have parallels in the commercial sector. Students who enroll in the class are expected to build on hands-on techniques that can be applied to the design process, to extend the efficiency and productivity of work during the process. For practical reasons, the course will use Autodesk Revit Architecture 2011, Green Building Studio and .NET framework. Prerequisite: 48-205.

Art Courses

60-101 Concept Studio I
Fall: 10 units
The Self and the Human Being* The first of a sequence of six studio courses designed to develop a personal approach to generating art and to learning transferable conceptual skills. The topics of the first three Concept Studios are addressed through a sequence of structured, media-independent projects. Open to freshmen admitted to the School of Art, or by instructor permission.

60-104 Contemporary Issues Forum
Fall: 6 units
This introductory class presents to students a diverse range of contemporary issues in the visual arts. It is organized in a thematic way rather than chronologically. There will be readings, discussions, and papers. Lecture/discussion format. All students are required to attend the School of Art lecture series. Open to freshmen in the School of Art, or by instructor permission.

60-110 Electronic Media Studio I
Spring: 10 units
Electronic Media Studio One (EMS1) is an introduction to the computer as a dynamic tool for time-based media production. In this course students develop skills in digital video and audio production through the exploration of narrative, experimental, performance, documentary and animation themes and forms. Historical and contemporary works are presented and discussed to provide a context for studio projects.

60-130 3-D Media Studio I
Fall: 5 units
An introduction to three-dimensional form. Various materials and methods are explored through projects covering a broad range of sculptural concerns. Art majors must complete one Mini-1 course and one Mini-2 course to satisfy the 3DI requirement. Students are required to select two of the following four sections: Wood Fabrication; Soft Sculpture; Light Metals Fabrication; Clay Modeling. Materials fee may be required. Open to freshmen in the School of Art, or by instructor permission.

60-131 3D Media Studio II
Spring: 5 units
Four unique mini classes offer an introduction to basic language and approaches of sculptural practice. Site Work: contextual practice approach where students consider art making using non-traditional materials, spaces and processes. Move It: kinetic art using exclusively non-electronic mechanical processes. Wearables: wearable objects that combine conceptual issues of body with performance, site, and audience. Animated Theater: explores the basics of electronic work with micro-controllers and strategies for using light, movement and imagery. Art majors must complete one Mini-3 course and one Mini-4 course to satisfy the 3DII requirement.

Materials fee may be required. Open to School of Art freshmen or by instructor permission.

60-141 Black and White Photography I
Fall and Spring: 10 units
This course will teach you the basic craft of photography from exposure of the negative through darkroom developing and printing to print finishing and presentation. Content includes student presentations, class discussions, shooting assignments, darkroom sessions and class critiques. We will concentrate not only on the technical aspects of photography, but also the aesthetics of seeing with a camera. The course concentrates on photography as a fine art — what is unique to it and the concerns that are shared with other visual arts, such as composition, tonal values, etc. and aims to equip students with an understanding of the formal issues and the expressive potentials of the medium. Lab fee and 35mm manual camera required. Each student is responsible for the cost of paper and film.

60-150 2D Media Studio: Drawing
Fall: 10 units
This course focuses on the language, materials and concepts of drawing as foundation for all the visual arts. Initial emphasis on the development of perceptual, analytical, and structural drawing skills with increasing attention to idea development. Exposure to methods of creating pictorial and illusionistic space; recording the external world of light and form; and making visible the internal world of the heart, the mind, the soul. Experience with line, texture, tone, shape and mass; in a variety of wet and dry drawing media. Open to freshmen in the School of Art, or by instructor permission.

60-160 2D Media Studio: Imaging
Spring: 10 units
A continuation of Two-Dimensional Media Studio: Drawing. Includes an expansion of drawing to include multimedia approaches, painterly issues, digital input/output and work with digital image processing tools. Prerequisite: 60-150.

60-200 Sophomore Review
Fall and Spring
Students present their work and their ideas about their work to a faculty committee. A successful review is required for advancement to the junior year. Although this is a non-credit course, it is required of all Art (BFA, BHA, BSA, and BCSA) sophomores.

60-201 Concept Studio II
Fall: 10 units
Space and Time* A continuation of Concept Studio I with a focus on space and time through projects of increasing complexity. Such topics as biological time, historical time, psychological time, celestial time, clock time, and public space, private space, mathematical space, and virtual space are addressed through projects. Open to freshmen in the School of Art, or by instructor permission. Prerequisite: 60-101.
60-202 Concept Studio III
Spring: 10 units
Systems and Processes*. A continuation of Concept Studios I and II with a focus on systems and processes. The utility, discovery, and the generation of systems and processes are addressed through projects. Open to sophomores in the School of Art, or by permission of instructor. Section B (Rich Pell) - This Concept Studio III section is a special edition of the Systems and Processes theme that will focus on the use of media to engage with the dynamic world we inhabit. This course considers the history, theory and practice of tactical media, hacktivism, and other media-based strategies of cultural expression, protest and critique. The course examines the social, economic and electronic networks that shape the world, and looks towards creative ways of intervening in these systems, as exemplified by such groups as The Yes Men, Critical Art Ensemble, Preemptive Media, Franoko and Eva Mattes and others. Students will develop several projects that employ skills in digital and physical media to create works that creatively engage with audiences in contexts that may not be traditionally associated with art. Open to non-art students.

60-203 Concept Studio: EcoArt
Intermittent: 10 units
An interdisciplinary studio course that provides an introduction to an art practice focused on ecology and the environment. Combines exploration of the history of environmental and ecological art with the production of creative projects that address issues related to sustainable practices. Shorter initial exercises and collaborative projects will precede and evolve into larger and more extended individual and/or collaborative projects. Considers both indoor and outdoor sites with an emphasis on context and the use of natural and recycled materials. Open to freshman and sophomores in the School of Art and to students in other disciplines.

60-204 Concept Studio: Networked Narrative
Intermittent: 10 units
Networked Narrative is a studio class that uses social networking sites such as Facebook, Twitter and YouTube as venues to develop fictional stories. The class will explore traditional and experimental narrative forms in a variety of media. Students will develop and produce narrative events that are exhibited on their fictional character’s various social networking sites.

60-205 Modern Visual Culture 1789-1945
Fall: 9 units
Explores the diverse roles of artists in the complexity of modern society from the Industrial Revolution through World War II. Contextual issues include the relationship of artists and art to culture, politics, economics and modern technologies. Attention is paid to the decline of patronage, the diminishing role of the academy and the emergence of an avant-garde and art promotion. Open to sophomores in the School of Art, or by instructor permission.

60-206 Contemporary Visual Culture from 1945 to the Present
Spring: 9 units
This course traces the shifts in art from late Modernism until our After Post era. It will examine the diversity of art produced, as well as the critical ideas that arose over a span of 60 years. The rise of a pluralist / conceptual art will be discussed within the context of social change, technology and globalization. Open to sophomores in the School of Art, or by instructor permission.

60-210 Electronic Media Studio II
Fall: 10 units
Electronic Media Studio Two (EMS2) is an introduction to software programming and physical computing within the context of the arts. In this course students develop the skills and confidence to produce interactive artworks using audiovisual, networked and tangible media.

60-244 Contemporary Photo Theory
Intermittent: 9 units
Because, you know, the photographs are more a question than a reply. (Sebastiao Salgado) A photograph is a moral decision taken in one eighth of a second, or one sixteenth, or one one-hundred-and-twenty-eighth. (Salman Rushdie) This seminar investigates current topics in photography and the image; our goals are twofold: identification of photo theory as it applies to current practice from both the viewpoint of maker and consumer. The course is designed to address philosophical issues for photographers working now and will favor conversation over written work; students are expected to fully participate in critical analysis and discussions. Readings include works by Roland Barthes, Stephen Shore, Susan Sontag, Hollis Frampton, John Szarkowski, Robert Adams, Italo Calvino, Berenice Abbott, John Berger and James Elkins. No pre-requisites.

60-245 Portrait Photography
Intermittent: 10 units
Portrait Photography explores the emotional and visual process of collaboration between subject and photographer that creates a photograph. We’ll use cameras of all formats and levels of sophistication to create portraits in the studio and on location. We’ll find and exploit available light and create artificial light to complete our vision, and we’ll explore a wide range of darkroom strategies to support and add richness to our final print. Through film and video we’ll meet some of the masters of this form like Arbus, Newman, Avedon and Penn, and we’ll take advantage of any opportunities to visit exhibitions and photographers studios. Lab fee required.
Prerequisites: 51-265 or 60-141 or 62-141.

60-250 2D Media Studio: Painting
Fall and Spring: 10 units
A pragmatic introduction to the tools, materials, and techniques of painting, including instruction in the fabrication of sound painting supports and the application of permanent grounds. Students become conversant with the range of visual options unique to the vocabulary of painting. Open to sophomores in the School of Art, or by instructor permission.
Prerequisites: 60-160 or 60-151.

60-251 2D Media Studio: Print Media
Fall and Spring: 10 units
An introduction to print media with emphasis on reproductive image making in the context of historical and contemporary practice. Students will be introduced to print processes such as intaglio, stencil, relief, linocut, lithography, serigraphy, and digital applications. Informed by readings, presentations on artists, and visits to museums, students will develop a body of work informed by and extending the traditions of print media. Open to sophomores in the School of Art, or by instructor permission.
Prerequisites: 60-160 or 60-151.

60-257 Computing for the Arts with Processing
Fall: 9 units
This course is an introduction to Java programming for designers, architects, artists and other visual thinkers, using the popular “Processing” Java toolkit for interactive graphics. Intended for students with little or no prior programming experience, the course uses interaction and visualization as a gateway for learning the traditional programming constructs and the fundamental algorithms typically found in a first course in programming. Students will become familiar with essential programming concepts (types, variables, control, user input, arrays, files, and objects) through the development of interactive games, information visualizations, and computationally-generated forms.

60-301 Making Connections: Individual Projects in the Community
Fall: 10 units
This course has an outreach focus, which allows students to create art outside traditional artistic venues. In developing their individual projects, students will explore what it means to be an artist outside the art school studio: how to make connections with a new audience; how to translate artistic vision into statements that are comprehensible and meaningful to a non-artist community; and how to apply personal aesthetics and interests to non-traditional settings. The types of projects chosen are limited only by the students’ imaginations: events, performances, temporary installations, graphics, sculptures, sound works, projected images, and interactive productions are only some of the varieties of projects that may be developed. Projects may be specific to a selected site, or they may address particular characteristics of a location, such as its history or physical setting, or its role in the community. Students may seek support from local organizations or institutions, or create works in collaboration with a selected community.

60-337 Advanced Printmaking: Intaglio
All Semesters
60-340 The Ballet Russe (The Russian Ballet) and its Artists
Intermittent: 9 units
The leading artistic position of the French Avant-Garde in the 1910’s and 1920’s was partly predicated on the assembly, meeting, collaboration and cross-influence of artists from all over Europe. The visual artists, musicians and performers brought with them specific aspects of their native heritage, therefore contributing to the enrichment of the general cultural scene. Paris with its cultural focal point the Ballets Russe became a melting pot of creativity.

60-347 Global Perspectives for Art
9 units
We find ourselves in a constantly intensifying global reality where increasingly there is a tendency beyond traditional boundaries. This seminar will explore the aesthetic concepts of the large historic cultures where there are bodies of articulated aesthetic philosophy: Western traditions from Plato to Heidegger, including Islam as integral to the Abrahamic/biblical traditions; the vast and rich array of aesthetic thought in Hindu, Buddhist, and Shinto cultures. In some specifically interesting cases, we will explore particularly small, isolated or ancient cultures, such as the Hopi or the Aborigines of Australia. In each case, we will explore ideas related to cardinal cultural ‘objects’ of each culture: architecture, painting, sculpture, performance/ritual, dance, film, and other media. We will expand our thought through various appropriate readings and discussions. Research themes can include: iconoclasm, cultural cooption, cultural orthodoxies and purifications, cultural transfers, cultural isolation and extremes, multiple cultural exchanges over long periods of time, cultural antagonism, cultural extermination and genocide, cultural transplants, cultural destruction and warfare, cultural distinctions, etc. Of particular interest will be the study and understandings of the roots of the iconoclastic, anti-art traditions and their constant struggle and interaction with the meanings and power of the icon, symbol and image. Students will be expected to do specific presentations based on research topics as well as our readings. A final research paper/project will be the major outcome of the course, and in some cases, this will be combined with an artistic project or performance.

60-351 Art & Religion
Intermittent: 9 units
Explores major artistic manifestations prompted by religious beliefs. Emphasizes visual arts in the context of historical, philosophical and eschatological explanations. Major religions are explored. This course is a history course (79-325) cross-listed in the School of Art. Requires sophomore status.

60-355 Rights to Representation: Indigenous Peoples and Their Media
Intermittent: 9 units
For decades anthropologists have been "pictures" others, in images as well as in words. This course explores the turn-around: when those who have been subjects of description take the opportunity to represent themselves. After a brief history of visual anthropology, we will concentrate on modes of representation developed by indigenous peoples. We will explore the meanings of "indigenous," in connection with various modes of representation, including film, dramatic performances, art, and the Internet. During the semester, we will compare—across time and space—the purposes for which media are used, the transmission of cultural values in media, the organization of production, and the intended audience. Anthropological method and theory will guide our inquiries. Course materials include disciplinary readings, documents dealing with indigenous rights, and examples of the work of indigenous peoples. Students should not take the course if they’ve already taken 79-303 as Visual Anthropology. Prerequisites: 60-105 and 60-205.

60-357 Picasso & 20th Century Art
Intermittent: 9 units
The greatest artist of the twentieth century, Picasso, invented or re-invented in most of the major styles of modern art. His artistic genius and visual inventiveness will be explored from 1894 (age 13) to his death in 1973 (age 92), against the background of eight decades of modern art. The focus of the investigation will not be limited to psychological and iconographic factors, but will be discussed in the historical and artistic context of his time.

60-358 Art and Biology
Intermittent: 9 units
A studio-laboratory art-making course designed to explore interactions between art and biology. It is an opportunity for students interested in interdisciplinary concepts to work both in a studio art environment and a biological laboratory. Students have the opportunity to experiment creatively with scientific media such as electron and video-probe microscopy.

60-360 Feminism - Art - Theory
Intermittent: 9 units
What happened when the women’s movement and the art world encountered each other? What is the relationship between the theory of art and the theory of feminism? Or between the practice of art and the practice of feminism? This course will take place on campus, and at the Mattress Factory, where I am curating an exhibition, “Feminist and”... which will open September 7th. The course will cover themes such as the gendered nature of culture, the practices of history and criticism; the interrelationship between feminist activism and art practice; notions of the aesthetic and if there are feminine or feminist aesthetics and representational forms; body, sexuality and representation; the representation of gendered national and racial identities. It will do this through looking at artworks, and through close readings of texts. Some of the material will engage with sensitive issues and challenging images, particularly around sexuality, and students taking the course must be prepared for and accepting of this. At the same time, full debate will be encouraged. The course is open to all students; preference will be given to MFA, senior and junior students.

60-366 Pop International
All Semesters: 9 units
Marcel Duchamp’s Readymades pointed twentieth century artist’s attention in the direction of reframing commodity culture and generated the potential to comment critically on the institution of art. Besides experimenting with strategies of reappropriation across painting, sculpture, and photography, artists associated with Pop Art used communication technologies to hijack popular culture’s ideologies as broadcasted through television, film, video, radio, and print. This seminar, tracks these Pop Art strategies from their inception in 1957 (the first to use the term “pop” programmatically was the British artist Richard Hamilton) through their contemporary legacies (exemplified by the work of Josh Smith, Kelley Walker, Takeshi Murakami, Monika Sosnowska, just to name a few). Discussions of selected works will be supported by theoretical and historical readings of British, French, German, Japanese, Chinese, Eastern European and American Pop art.

60-371 Breathless: International New Wave Cinemas
Intermittent: 9 units
What does Jean-Luc Godard’s “Breathless [A’bout de souffle] (1959) have in common with Wong Kar-Wai’s “In the Mood for Love” [Fa yeung nin wa] (2000)? What does Satyajit Ray’s “Pather Panchali” (1955) share with Mark LaPore’s “The Glass System” (2000)? By examining an array of films from the classic days of International New Wave Cinemas, beginning with French Nouvelle Vague, Indian “Parallel Cinema,” as well as German, Italian and Japanese innovations and moving to contemporary (and experimental) film movements in Iran, Korea, Hong Kong, Eastern Europe, and the US, we will explore the ways a handful of young directors found novel ways to fund and shoot their movies in direct defiance of commercial, narrative, and cultural norms. By focusing on mise-en-scene over thematics, on-site locations over studio studios, lesser-known actors over box-office idols, and small production teams over professional crews, these directors were able to turn to lo-fi aesthetics and financial shortcomings into a radical new filmic style. Especially central here will be how forms of cinematic experimentation that translated internationally—and how these approaches continue to challenge hegemonic forms of media culture.

60-373 Aesthetics from a Global Viewpoint
Intermittent: 9 units
The arts and their making is a behavior that differentiates our species. Artistic/aesthetic differentiation is a global phenomenon occurring since the dawn of our species. This seminar will explore the articulated aesthetic philosophy of large historic cultures: Western traditions from Plato to Heidegger, including Islam as integral to the Abrahamic traditions along with the vast and rich array of Hindu, Buddhist, and Shinto aesthetics. These broader traditions may be examined along with additional examples from small, isolated or ancient cultures, such as the Hopi or the Aborigines of Australia. Across cultures, we will explore the aesthetics of cardinal cultural “objects” (architecture, painting, sculpture, performance/ritual, dance, film, and other media) through readings and discussions. Each student’s individual definition of the nature of the arts will be constantly measured with and against the ideas of other cultures, all developing an interactive and integrative dialogue. Other issues include: the study and understandings of the roots of the iconoclastic traditions and their constant struggle and interaction between the meanings of the icon and the image; the notion of cultural “otherness”; and how aesthetic problems manifest themselves in our world in immediate and violent ways; and the evolution of the drive for the preservation of cultural memory in light of recent destructive events in Afghanistan and Iraq.
60-375 Art History/Theory: Contemporary Likeness, Identity and Culture
Intermittent: 9 units
This course explores the issue of identity in the visual arts emerged in a new light with the shift from a modernist to a postmodernist paradigm since the mid 20th century. When we speak of identity, what do we mean? How does cultural identity contribute to the formation of personal/private identity & vice-versa? How is this reflected in an artist’s work in this time? This class will examine the evolution of human portrayal from the time of Andy Warhol to the present. Through readings, discussion & presentations the class will focus on how identity & human portrayal has evolved over time & how theory, popular culture, the cult of the ‘glam celebrity,’ & technology have played an influential role in reshaping the concept of human portrayal & identity—each challenged the hierarchical pretext regarding the portrait & images of likeness in our culture today. Thanks to photography & cyber-technology no longer is a portrait revered as a unique or rarefied object but a conglomeration of cultural influences. We will look at the works of a diverse range of artists, as well as non-artists, & consider how media affected the evolution of the portrayal of the human face & creation of persona. Images of individuals were once viewed as a primary indicator of national identity, social status, religious belief, as well as a signifier of historical events influenced by particular ideologies. Nowadays images of the self & others, prompt viewers to consider a wide range of psychological, spiritual, & political information beyond visual manifestation. Two basic questions “Who are you?” & “What is art?” often come together in the contemporary portrait. Most portraits are negotiations between identity & representation, between being a subject & portraying a subject. Representations of people represent a mark of contemporary life that personal identities have become fractured, complex, & splintered, and that they are in a state of constant re-definition.

60-376 Large Format Photography: The Antiquarian Avant-Garde
Intermittent: 10 units
This course takes part in the anti-digital movement by exploring the roots of photography. Students will shoot with an array of large format cameras and use 19th and 20th century processes to create “one-of-a-kind” photographic images. Course topics include non-silver printing processes, pinhole photography, and contemporary tin-types. Prerequisites: 60-141/62-141/ equivalent or consent of instructor.

60-377 Picasso and 20th Century Art
Intermittent: 9 units
The greatest artist of the twentieth century, Picasso, invented or participated in most of the major styles of modern art. His artistic genius and visual inventiveness will be explored from 1894 (age 13) to his death in 1973 (age 92), against the background of eight decades of modern art. The focus of the investigation will not be limited to psychological and iconographic factors, but will be discussed in the historical and artistic context of his time.

60-380 Color Photography and Digital Output
Fall and Spring: 10 units
This course explores both the aesthetics and science of light, color and perception in contemporary imagemaking practice. Students will explore digital color photography with digital printing methods through concept driven projects. Emphasis is placed on assisting students to develop their individual approach to creating work. Students create and print images using Mac OS and Adobe Photoshop. Prerequisites: 51-265 or 60-141 or 62-141.

60-381 Museums and other Exhibition Spaces
All Semesters: 9 units
This class provides students with an introduction to the history and function of museum/art spaces and an understanding to the effect of museum exhibitions on our notion of history, arts, culture and society. This course is geared to artists as they prepare to go into the post-graduation enigmatic art world and for students desiring to pursue a career in curating. Focus is on the actual and ideal museum and art galleries, alternative spaces, biennials, art collectives, virtual options as well as a variety of venues to showcase art and culture. It will analyze not so visible skirmishes, hidden economics, and the complex ways artists and curators interact with institutional power. We will concentrate on showcases for art in the Pittsburgh region and visits to museums and exhibitions will be an integral part of this course. Topics to be covered through lectures, discussions and readings include: national galleries, city museums, art centers, artists studios, museums, as treasures of culture and of cultures, museum education, architecture, the idea of the canon in art, political correctness in exhibitions, collections and collecting, ethical issues, acquisitions and de-accessions, design and installation, conservation, sculpture gardens, private houses and art museums, donor memorials, museums in the public and private spaces, museums in the city, and the role of museums in contemporary society. We will explore controversies relating to museum acquisitions and to the looting of cultural goods.

60-382 Theory and Practice of the Art Museum
Intermittent: 9 units
This class is an introduction to and overview of the missions, operations and history of museums, focusing on art-related institutions such as galleries, and non-profit spaces. The course will provide a broad introduction to the field of museum operations. Topics included will be the history and philosophy of museums, the social, economic and political trends that shape museums; the staffing, management and financing of museums; and the multiple functions of museums - collection and care of objects, exhibition design and interpretation, education programs, research activities and public relations. Discussions will also address cultural policy change as society has evolved and new historical and theoretical models have risen over the past two decades. The course will combine lectures, both by the instructor and visiting lecturers; discussion of readings and videos; field trips to museums; and a semester-long group project.

60-398 Social History of Animation
Intermittent: 9 units
Social History of Animation will investigate the history of animation from early experiments with trick film through the development of major studios, to independent and web based work. Social movements and technological innovation will be analyzed and discussed in relation to the effects they had on animators and their work. This class will read related texts and view US and international examples to explore animation as a means for personal expression and as a reflection of the context in which they were made.

60-399 Art History/Theory Independent Study
All Semesters: 9 units
A tutorial course in which an Art student works individually on a self-generated project under the supervision of a School of Art faculty member. Prior to enrolling in Independent Study, the student must complete an “Independent Study Proposal” form (available in the bins on the 3rd floor of CFA) which is signed by the faculty member and the Assistant Head of the School of Art. Prerequisite: Art junior or senior status, or by instructor permission.

60-400 Senior Review
Spring
Students present their work and their ideas about their work to a faculty committee. This review affords graduating students the opportunity to analyze and summarize their work, and to engage a faculty committee in discussion about issues that face an artist preparing to enter a career in art. Although this is a non-credit course, it is required of all Art (BFA, BHA, BSA and BCSA) seniors.

60-401 Senior Studio
Fall: 20 units
Students initiate a comprehensive two-semester project in the first semester to be continued and completed in the second semester of their senior year (60-402). Each student pursues an ambitious and cohesive body of work with guidance by a team of School of Art faculty. Multimedia, interdisciplinary, and collaborative work is encouraged. Studio work is supplemented by group critiques, workshops on writing, professional presentation skills, career preparation, and technical instruction as needed. Attendance at all 5pm School of Art Lecture Series events is required for this class. Open to seniors in the School of Art, or by instructor permission.

60-402 Senior Studio
Spring: 20 units
Students continue a comprehensive two-semester capstone project. Each student pursues an ambitious and cohesive body of work with guidance by a team of School of Art faculty. Multimedia, interdisciplinary, and collaborative work is encouraged. Studio work is supplemented by group critiques, workshops on writing, professional presentation skills, career preparation, and technical instruction as needed. Attendance at all 5pm School of Art Lecture Series events is required for this class. Open to seniors in the School of Art, or by instructor permission.
60-408 Advanced ETB: the Manipulated Moving Image
Intermittent: 10 units
The manipulated moving image has virtually unlimited potential to visually represent events, scenarios and forms that have little or no relation to our everyday experience of the tangible, extant world. In this course you will use digital and analog tools and techniques and your imagination to create movies that do not represent the way the world is, but do represent what you want it to be and/or how you are afraid it might become (Utopian/Dystopian impulses, Eros and Thanatos). The manipulated moving image is a somewhat awkward but more inclusive word than “animation” for moving image forms that include animation, motion graphics, compositing and visual effects in various combinations and permutations. In a way, digital tools have allowed moving image-makers to create works that have less to do with film and more to do with music and painting. Some of the techniques we will explore include: object animation, cutout animation, pixilation, collage, rotoscoping, motion tracking, and compositing. There will also be a focus on audio production and post-production with an emphasis on digital animation. The primary software tools students will be instructed in and use include Adobe After Effects, Photoshop, and Apple Logic Pro. Prerequisite: 60-110.

60-409 Advanced ETB: Video & Performance
10 units
This studio course will concentrate primarily on the historical and ongoing relationship between video and performance. That said, this course will be flexible enough to allow students to create video, performance and video/performance projects. Class time will be spent considering the history of performance and video/performance, viewings of primarily video/performance works to provide background and inspiration, presenting and critiquing student projects and studio time to work on projects. Technical instruction in video editing, compositing and effects, audio recording/editing and midi applications will be offered on an as needed basis. Prerequisite: 60-210.

60-410 Advanced ETB: Moving Image Magic: Visual Effects, Animation and Motion Graphics
All Semesters: 10 units
Fly like Harry Potter, return to the Land of Oz, journey into the farthest reaches of the universe, or take a head-trip into the inner reaches of your subconscious. It’s all possible in Moving Image Magic! This course serves as an introduction to the creation of personal extraordinary cinematic visions using a variety of analog and digital tools and techniques. These include: stop motion animation, compositing, motion tracking, digital matte painting, miniatures, rotoscoping, text animation and motion graphics. The primary software tools that students will use are Adobe After Effects CS5 Pro and Adobe Photoshop CS5 extended. Prerequisite: 60-210.

60-412 Interactive Art and Computational Design
Intermittent: 10 units
This is an advanced studio course in arts computing and new media practice. Topics covered in the course will be tailored to student interests, and may include: experimental interface design, information visualization, game design, real-time audiovisuals, locative and mobile media, computational form-generation for rapid prototyping, image processing and vision-based interactions, augmented reality, simulation, networked crowd-sourcing, dynamic typography, mechatronic and device art, physical computing, and other topics. Through a small number of exploratory assignments and a public capstone project, students will bolster interdisciplinary problem-solving abilities and explore computation as a medium for curiosity-driven experimentation. Enrolling students are expected to have demonstrable programming skills, without exception, at or beyond the level of an introductory class such as 15-110. Although the course will provide technical overviews of major arts-programming toolkits (including Processing, Max/MSP/Jitter, openFrameworks, and Arduino), assignments may be executed in the student’s preferred programming environment. Graduate students should register for sections 62-726 (12 units), which meets with the undergraduate sections 60-412 and 51-482 (10 units). Students lacking the programming skills for this course are encouraged to take 48/51-60-257 Computing for the Arts with Processing (J. Roberts). Prerequisites: 15-110 or 60-112.

60-413 Advanced ETB: Experimental and Abstract Animation
All Semesters: 10 units
Adv. ETB: Experimental and Abstract Animation — This course will explore experimental and abstract animation from a fine arts perspective and emphasize exploratory, formal and cultural/political motivations. Exploratory is the important term here as students will experiment wildly to develop a personal vision and method of creating one’s work. Using a variety of strategies, techniques, and tools students will create experimental and/or abstract animations. Some of the animation techniques explored will include: 3D stop motion digital photography, copy machines, drawing (analog & digital) painting (analog & digital), cutout, collage, scanners and more. There will also be a strong component on developing audio production and post-production skills with an emphasis on audio-visual relationships. The primary software tools include Adobe After Effects and Photoshop, and Apple Logic Pro. This course is especially suitable for those students who are interested in creating animations using their drawing, painting and object making skills.

60-414 Advanced ETB: Animation Art and Technology
Spring: 12 units
Animation Art and Technology is an interdisciplinary course cross-listed between Art and Computer Science. Faculty and teaching assistants from computer science and art teach the class as a team. It is a project-based course in which four to five interdisciplinary teams of students produce animations. Most of the animations have a substantive technical component and the students are challenged to consider innovation with content to be equal with the technical. The class includes basic tutorials for work in Maya leading toward more advanced applications and extensions of the software such as motion capture and algorithms for animating cloth, hair, particles, and grouping behaviors. The first class will meet in CFA room 303. Prerequisite: 60-110.

60-415 Advanced ETB: Animation
Fall: 10 units
This studio will introduce students to a variety of 3-D computer and 2-D drawn animation techniques. The class will look at and discuss examples of historic and contemporary animation. The students will explore animation through a variety of short experiments and develop individual projects that use animation as a means of self expression. Prerequisite: 60-110.

60-416 Advanced ETB: Interactive Multimedia
Intermittent: 10 units
Within this class students will engage in a personally directed exploration of the creative, conceptual and tactical possibilities of interactive scenarios within their art practice. The term “interactivity” will be used and discussed in its broadest possible context, and students will be given space to explore a wide range of digital and non-digital approaches to user oriented strategies within the art making process. We will also examine and discuss a range of historical and contemporary strategies employed by art makers who have used forums from on-line and virtual spaces to physical and site specific venues to expand and explore the relationship between the art object and the audience. Prerequisites: 60-110 and 60-210.

60-417 Advanced ETB: Video
Intermittent: 10 units
This course offers an in depth exploration of video as a tool for creative expression. Topics for investigation and discussion will include: histories of experimental video, contemporary trends in the field, technological developments, performativity, perception and manipulation of time, and theories of representation. Additionally this course will provide instruction in advanced production and post-production techniques, including lighting, editing, compositing, 2D animation, graphics and sound design.

60-418 ETB Studio: The Interactive Image
Intermittent: 10 units
60418 The Interactive Image (Golan Levin). This course is an introduction to the use of interactive graphics as an expressive visual tool. It is a “studio art course in computer science,” in which the objective is art and design, but the medium is software. Absolutely no previous programming experience is necessary. Rigorous exercises in a java-based OpenGL graphics environment will develop the basic vocabulary of constructs that govern static, dynamic, and interactive form. Topics include the computational manipulation of: point, line and shape; texture, value and color; time, change and motion; raster, vector and 3D graphics; reactivity, connectivity and feedback. Students will become familiar with basic software algorithms, computational geometry, digital signal filtering, kinematic simulation, and the application of these techniques to aesthetic issues in interaction design. This course can be repeated with the permission of the instructor.
60-421 Computing for Live Performance with Max/MSP/Jitter
Intermittent: 10 units
This hands-on and highly interdisciplinary studio course is an introduction to the use of Max/MSP/Jitter, a visual programming environment for controlling interactive music, audio, video, and many other electronic media. For more than 25 years this software has been used by artists, musicians, and stage designers to create their own custom programs for algorithmic compositions, interactive installations, live environments and real-time performances. The simple visual interface of Max/MSP/Jitter allows non-programmers to create their own software without having to learn or to write traditional "code". Instead, users connect together pieces from a vast library of functional objects that manipulate and control sound, video, and other effects (such as DMX lighting) in response to sensors like cameras, microphones, game controllers, MIDI devices, and custom electronics. Students will be exposed to the fundamentals of multimedia programming in Max, the basic building blocks of sound and video, and techniques for integrating data from external sources, such as the popular Arduino microcontroller. They will also gain the practical knowledge and problem-solving skills to develop and design their own interactive installations, sculptures, and instruments for performance-based art or experimentation. No previous programming experience is necessary. Prerequisites: familiarity with the Mac OS.
Prerequisites: 60-110 and 60-210.

60-422 Advanced ETB: Robotic Art Studio
Intermittent: 10 units
Advanced ETB: Robotic Art Studio (Fabian Winkler). The Robotic Art Studio is an experimental and interdisciplinary class. It focuses on three areas: technical workshops exploring basic electronics, the presentation and discussion of key texts relevant to robotic art and the creation of individual art works. In the technical workshops students will explore the functionality of basic electronic components, work with sensors, actuators and alternative power sources such as solar energy. In the discussion of assigned readings, we investigate some of the cultural, social and technological issues inherent to the field of robotics. These discussions will be complemented and extended by presentations of relevant historic and contemporary artworks. Students will also work on a variety of different project assignments, some of them exploring the networking of individual work to a system. A course material fee is required. Students can expect to purchase some individual items outside of those provided if they are unique to their project design.

60-423 ETB Studio: Audio Visual Systems and Machines
10 units
The idea of a synaesthetic bonding of sound and image is a recurring motif in art, design and cinema; new technologies provide powerful new tools with which to explore that idea. Major topics in this studio course will include: static and dynamic visualizations, visual notation and scoring systems, information sonification, sound for film and animation, and interactive systems for audiovisual play and performance. We will also give attention to psychoacoustics, computer graphics, sound synthesis and analysis techniques, abstract film, and other related fields. The first half of the semester will focus on rigorous weekly assignments aimed at exploring creative mappings between the auditory and visual domains. The second half of the course will develop individual projects, culminating in an evening of public installations, screenings and performances. This course is cross-listed between the Schools of Art, Design and Music.

60-425 Advanced ETB: Live Video
Intermittent: 10 units
Advanced ETB: Live Video - Using analog and digital tools, software and hardware, students will create independent and collaborative live video performances and events. Additionally we will engage in study and discussion around issues of liveliness, mediation, representation and embodied experience.

60-428 ETB Studio: Information Visualization
10 units
Traditionally the tool of the statistician and engineer, information visualization has increasingly become a powerful new tool for artists and designers as well, allowing them to present, search, browse, filter, and compare rich information spaces in order to reveal thought-provoking but often obscure hidden narratives. Like many visualization courses, this class will examine computational techniques for displaying temporal, spatial, hierarchical, and textual data. The class will also focus on visualization strategies from the "designer's perspective," exploring how to decipher and represent data in ways that make it meaningful for others, and on critical and conceptual applications of visualization from the "artist's perspective." Emphasis will be placed on the origin of data, as well as what information is worth visualizing and why. This course is heavily project-oriented; students should have programming skills or an interest in learning how to apply computation to their work.

60-430 Advanced SIS: Open Sculpture
Intermittent: 10 units
Sculpture is perhaps the broadest field among the contemporary visual arts. Through its privileged relationship to the physical world and the viewer's body, sculpture is the glue that connects the intermedia practices of object, installation, interactive art and performance. In this class we build on skills and concepts learned in 3D media 1 and 2 to develop students' individual approach. Students define independent responses to topics proposed through discussion of contemporary sculptors. Emphasis is placed on individual development. Students are encouraged to explore interdisciplinary approaches.

60-431 Advanced SIS: Installation
Intermittent: 10 units
At the heart of installation art is the desire to immersively engage the viewer in unanticipated spaces and environments in which visual and intellectual habits are challenged or disrupted. Installation is not defined by medium, or site, but by a continual struggle to expand the relationship between the artist and the audience. In addition to creating works for "neutral" spaces, like galleries and museums, students will also be producing work within the preexistent social, architectural, and sensory fabric of their daily lives. As installation art is an ever-expanding territory, we will start with the term "space," and what constitutes its myriad definitions, as a nexus for inquiry and production. This class encourages enrollment from students in any discipline, inside or outside of the School of Art.

60-432 Advanced CP/SIS Site-Work Braddock
Intermittent: 10 units
Then: 20,879 residents. A booming steel industry. Carnegie's first free library. Trolley cars. Schools. Department Stores. Movie theaters. Now: 2,917 residents. 250 homes left in ruin. Abandoned churches, storefronts and commercial buildings. One progressive-thinking mayor. In this course, we will unpack and explore the city of Braddock, PA. We'll delve into the various facets of the community to create a picture of this city that encompasses its rich history and future potential. We'll conduct ethnographic interviews by visiting community groups, civil servants, residents (long-time and new), and individual community members. We'll collect histories: oral, written and visual. We'll use ethnographic methods to study and understand the multi-layered scope of this city. Once we've worked together to create a picture of Braddock, students will develop and propose a final project. This class meets on campus (Mondays) and in the city of Braddock (Wednesdays). We will carpool or take buses together. Students should plan on leaving campus at 1pm, and should schedule their classes accordingly. The course will culminate with an exposition of the students' project in Braddock with support from the Mayor.

60-433 Advanced SIS: Clay
Intermittent: 10 units
Studio focus on ceramic materials and processes as applied to sculptural issues. Fabrication, glazing, and kiln-firing are addressed. Material fee required. Prerequisite: 60-130.

60-434 Advanced SIS: Foundry
Intermittent: 10 units
Studio focus on metal casting processes. Objects are created in clay, wax, wood and plaster and cast into bronze or aluminum. Fabrication and welding techniques are presented. Materials fee required.

60-435 SIS: Metals
Intermittent: 10 units
Studio focus on fabrication using light metalworking techniques including forming, joining, and finishing. Metalsmithing and jewelry techniques will be explored in the context of sculptural issues. Metal stretching, forging, brazing, texturing, small scale casting and coloring are also presented. Slides looking at small scale metalwork, as well contemporary sculpture using metal techniques will be presented periodically. Metals provided include copper, brass, and bronze sheet and wire. Materials fee will also cover silver solder and other expendables.
60-436 Advanced SIS/ETB: Digital Fabrication for the Arts
Intermittent: 10 units
This is a class about making physical objects for sculpture, installations, and other art practices using computers and digital fabrication machinery. The tools will be object modeling software packages, rapid prototyping technologies, and computer numeric controlled (CNC) machining technologies. The facility of such tools in the making of multiples, mechanisms for kinetic/mechatronic work, morphology generated by code, and objects that mix the forms of contemporary mass-produced design will be explored. A smattering of techniques for modeling different types of shapes and functionalities will be covered. That the hand, mind, and eye of the artist remain their primary tools, even in the environment of machinic ubiquity, is a primary revelation of the class. The physical still evades the virtual’s desire to simulate it, predict it, and form it.

60-437 Advanced CP/SIS: Environmental Sculpture
Intermittent: 10 units
Studio focus on sculpting with the environment. Includes object making, installations and site work with an emphasis on ecological materials, growing systems, environmental impact and related issues. Students required to explore and develop proposal-making skills in order to acquire permission for sites in which to implement projects. Both individual and collaborative projects are possible.

60-438 Advanced SIS: Intimate Objects
Intermittent: 10 units
Advanced Sculpture Special Topics: The intimate object - exploring the issues of small scale sculpture. This class will deal with the creation of objects that require a one on one interaction with the viewer. Unlike much heroically scaled sculpture, there is a distinctly personal and intimate connection that these objects engender. The class will look at historical examples, as well as 20th century works starting with the daida and surrealists. Problems of small scale sculpture will include topics such as the miniature versus actual size, the nature of materials, the issues of craftsmanship, the problem of preciousness. This class is open to advanced sculpture students working in any media.

60-449 Advanced CP: Experimental Talk Show Lab
All Semesters: 10 units
Students in this class will be working with local community members to push the boundaries of live broadcast performance. The class will use the interactive dynamics of The Waffle Shop, a neighborhood restaurant that produces and broadcasts a live-streaming performance show with its customers and community members as an experimental platform and lab. Students will work in collaboration with community members to conceptualize, script, produce, direct, make sets, and sometimes perform. Students will have a selection of community partners they can work with including a comedian, a cook, a jeep game show, a hip-hop youth program, an experimental chef, a hairdresser, a political action group, and more. This is a truly interdisciplinary class and students from throughout the university, in addition to the School of Art and the School of Drama, are encouraged to enroll. More info at: www.waffleshop.org <http://www.waffleshop.org>.

60-450 Advanced DP3: Drawing
Intermittent: 10 units
Studio focus on drawing experiences designed to develop observational, compositional, technical, expressive, and conceptual skills. Emphasis on independent work, and on the integration of drawing with work in other media.
Prerequisites: (60-150) and (60-151 or 60-160).

60-453 Advanced DP3: Painting
Fall and Spring: 10 units
In this course you will be encouraged to expand your skills and develop a personal vision, while maintaining a spirit of investigation into the developmental process, the magic, the illusion and the physical reality of painting. The professor will act as critic and advisor as students work independently developing self-generated ideas and setting personal goals. We will meet as a class for group critiques, discussions, presentations on the practical aspects of the profession, and slide lectures on contemporary artists.
Prerequisite: 60-250.

60-455 Advanced DP3: Intaglio
Intermittent: 10 units
Advanced Intaglio studio focuses on the development of additional techniques such as lift and soft grounds, photographic processes, color and multiple plate printing, and viscosity printing. Emphasis will be placed on artistic/image development in relationship to the print as a democratic multiple. In addition cross disciplinary work will be encouraged within other printmaking studios to expand the visual vocabulary and image development.
Prerequisite: 60-251.

60-456 Advanced DP3: Lithography
Intermittent: 10 units
Studio focus on the processes and issues of lithographic printmaking. Includes both traditional stone and aluminum plate processes along with photographic techniques.

60-458 Advanced DP3: Serigraphy
Intermittent: 10 units

60-462 Advanced DP3: Rethinking Mixed Media & What’s Flat
Intermittent: 10 units
This course focuses on your ability to generate ideas and execute a strong and significant body of work in 2D mixed media. As an advanced student you are expected to reach some conclusion about the direction of your work and want to produce and develop your work. Research and experimentation in medium and process is expected along with developing ideas and exploring content and expression. Periodic writing will be required to support your creative research. There is a long history of 2D artists mixing materials and generating more than meets the eye. Materials, process and content will be discussed with emphasis on mixing and integrating orthodox and unorthodox mediums as a way to develop image making that goes beyond the ordinary. Medium process will be discussed but instruction in learning a medium (techniques) will generally not be covered. A variety of critique formats will be maintained weekly along with periodic slide lectures and discussions on artists and critical articles. Where does 2-D end and 3-D begin and have you heard of the talking 2-D work or the 2-D performance, or the flat tube? This course is about engaging in the mixing/combing of 2-D work, including installation, site consideration and other potential mediums.
Prerequisites: 60-150 and 60-250.

60-463 Advanced DP3: Print/DRAW
Intermittent: 10 units
This course will focus on the development of technical and conceptual strategies in drawing AND/OR print media. With students working in either or both areas, the class the function as a studio workshop in which students set personal goals and strive to produce a significant body of work. Students will be expected to experiment and to create their own problems/limitations, while investigating a range of materials and considering the relationship between form and content. Individual and group critiques will help guide students; presentations on artists, readings, and field trips will contextualize the group’s work.

60-467 Advanced CP/DP3: PrintInstallation
Intermittent: 10 units
This course offers an inclusive approach to print media informed by the ever-expanding definition of image making. It will examine the role of print media in and as installation, addressing the medium in context, and as a multiple. Individual student work will play a fundamental role in class projects, however collaboration will also be encouraged. Course content may involve, but is not limited to: digital, silkscreen, lithography, and intaglio. Experimental methods of print production are also welcome. Course dialogue will address issues of audience, accessibility and context as related to the construction of meaning. One-on-one meetings and group critiques will be routine. There will be power point presentations on contemporary artists as well as assigned readings.
Prerequisite: 60-251.

60-471 Advanced DP3 Drawing: The Figure, Anatomy and Expression
Intermittent: 10 units
For thousands of years artists have seen the human body as an object of beauty, and as a powerful metaphor for documenting the passion and the pathos of human experience. This course will focus on that complex and compelling subject. In class, students will work from the model, studying the figure as a means to heighten sensitivity, expand visual perception, and refine drawing skills. An introduction to the landmarks of anatomical bone and muscle structure will be included. Outside class, students will be encouraged to seek meaning in the humanity of the figure as a vessel for expression, be it personal, social, political, spiritual, narrative or emotional.
60-472 Mutable Landscape: Drawing and the Digital Photographic Image
Intermittent: 9 units
Through investigations of social & historical uses of photography and the landscape, students will develop their own portfolios of digitally informed, camera-based images. The class will leave the studio behind to explore, document and invent a sense of place in Pittsburgh. As a CFA Interdisciplinary class, students will be encouraged to consider implications of the landscape and image in the medium of their home department. Although the class will engage issues of medium and materiality, this is not a software class. Students should have some familiarity with the Mac. No prerequisites.

60-475 Advanced CP/DP3: Print Media
Intermittent: 10 units
This course offers an inclusive definition of print media that recognizes historical and contemporary tools, techniques and practice. Reproductive image making will be addressed within the context of traditional print media equipment, digital arts output and experimental methods. Essays and lectures on contemporary artists will aid student knowledge of current dialogue and strategies for addressing the printed impression. This course expands upon the theoretical and conceptual themes introduced in Print Media I with emphasis on student-conceived projects led by faculty advising. Prerequisite: 60-251.

60-486 The Art and Science of Color
Intermittent: 10 units
This interdisciplinary course will consist of a combination of chemistry lecture & labs with studio art & art history. The focus of the course will be on the intersection of painting practice with chemistry, particularly in the study of pigments of mineral & inorganic origin. This is a project course open to majors in chemistry & art. The course & its projects are designed to expand the expertise of students in each discipline, while exposing them to the methods, demands, & aims of the other. Historically, the craft of painting was closely linked to the practice of pigment manufacture, with painters procuring their materials in raw form directly from the chemist/apothecary, & often performing themselves the final purification & grinding of the minerals into pigments. Color has been used by both artists & alchemists as a benchmark for tracking changes while creating new materials based on minerals found in nature. With the advent of mass-produced & marketed pigments, & the class will make field trips to local research labs & museums.

60-499 Studio Independent Study
All Semesters
A tutorial studio in which an Art student works individually on a self-generated project under the supervision of a School of Art faculty member. Prior to enrolling in Independent Study, the student must complete an "Independent Study Proposal" form (available in the bins on the 3rd floor of CFA) which is signed by the faculty member and the Assistant Head of the School of Art. Prerequisite: Art Junior/Senior status and by instructor permission.

60-540 The Artist as Entrepreneur
Fall: 3 units
This course is designed for senior (BFA, BHA, BSA and BCSA) and graduate Art students who wish to continue making, showing, and selling work after completing their studies. The focus of this course is on helping students develop the skills and knowledge necessary to establish themselves as working professional artists. Topics include: marketing and promotions, galleries and other exhibition opportunities, pricing work, contracts, taxes and related matters, dealers, grants and other fundraising, other income sources, finding health insurance, and finding and connecting with a community of artists. Students will create professional materials including a resume, business card, promotional post card and mailing list - and will be graded on these materials. There will also be required readings, class speakers and graded journals in response to these activities.

60-590 Internship
Fall and Spring
Art Internships are open to all BFA, BHA, BSA and BCSA Art students. Internships may take place with appropriate individuals or organizations within or outside of Carnegie Mellon University. The requirements for an internship are in the School of Art "Undergraduate Handbook" (available at the School of Art website). Prior to being enrolled for an internship, students must complete an Internship Proposal Form, which defines the goals of the internship. This form must be signed by their site supervisor and approved by the Assistant Head of the School of Art. Forms are available in the bins on the 3rd floor of CFA. Junior and Senior Art majors only.

Biological Sciences Courses
03-050 Study Abroad
Fall
03-051 Study Abroad
Spring
03-101 Biological Sciences First Year Seminars
Spring: 3 units
Various seminars are offered that introduce first-year students to current topics of modern biology. These are mini courses that meet for half a semester. Topics have included: Proteins in Disease, Genes and Diseases, Pills and Poisons, Curing Cancer, Organ Transplantation & Blood Substitutes, and Prions --- Mad Cows and Englishman. Courses restricted to first year students in the Mellon College of Science.

03-115 Phage Genomics Research
Fall: 6 units
This course will provide an introduction to biological investigation through a research project in bacteriophage genomics. Genomics combines experimental and computational approaches for large-scale analysis of the biological information contained in DNA sequences. The ability to analyze the complete DNA of any organism has revolutionized modern genetics and is influencing many areas of biology and medicine. The most abundant biological entities are bacteriophages (viruses that infect bacteria). Their enormous diversity and number make bacteriophages important models for the study of gene structure, function and regulation, population genetics and evolution. In addition they are the source of important tools in biotechnology. The research goals of this course will be to identify new bacteriophage species and incorporate them into a comparative genomic study to better understand the genetic organization and evolution of these organisms. While accomplishing these goals students will develop an understanding of the research process, including the ability to design experiments and interpret novel data. Fall semester: Samples will be collected in the field. From these samples students will identify and purify bacteriophages. The bacteriophages will be characterized structurally by electron microscopy, and their DNA will be purified and sequenced. Corequisites: 03-121, 03-110.

03-116 Phage Genomics Research
Spring: 6 units
Spring Semester: The DNA sequences will be analyzed with bioinformatic tools and compared with those of phages isolated at other locations to identify genes, their organization, the differences that may characterize different phage groups, and how these have arisen during evolution.

03-121 Modern Biology
All Semesters: 9 units
This is an introductory course that provides the basis for further studies in biochemistry, cell biology, genetics and molecular biology. This course emphasizes the chemical principles underlying biological processes and cell structures as well as the analysis of genetics and heredity from a molecular perspective. This is the introductory biology course for all science and non-science majors.

03-122 Organismic Botany
Intermittent: 9 units
This course provides an integrated overview of botany at the level of organism and above, including historical perspectives. It provides an introduction to the subdisciplines of systematics, evolution, plant geography, and ecology, and surveys the anatomical, morphological, developmental, and environmental diversification of major groups within the plant kingdom. Prerequisite: 03-121.
03-124 Modern Biology Laboratory
Fall and Spring: 9 units
This laboratory is designed to introduce students to modern concepts in the biological sciences. The experiments illustrate many of the principles covered in 03-121 and 03-290. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course. Special permission required. Corequisite: 03-121.

03-125 Evolution and History of Life
Fall: 9 units
Evolutionary theory is the unifying principle of biology. A good comprehension of the concepts that underlie this theory is therefore important to properly appreciate and understand any biological process. This course is designed for students intending to continue studies in biology so that they may gain an understanding of the evolutionary framework in their more advanced courses, and also non-biology majors who want to extend their knowledge of biology at an introductory level. The lectures will include (i) an examination of the history and development of evolutionary theory, (ii) consideration of some of the facts that have established the theory, (iii) an introduction to the concepts of phylogenetics, (iv) discussion of the patterns and mechanism that lead to the diversity and origins of the groups of life, (v) an introduction to genetics and population genetic theory, and (vi) discussion of and how this applies to natural selection and speciation. The course will also include some more specialist topics, including evolution of development, sexual selection, evolutionary applications to medicine and conservation biology, and genome evolution. Assessment will be based on several in-class exams and quizzes, homework assignments, a written term paper, and a final exam. Prerequisite: 03-121.

03-126 Cellular Response to the Environment
Fall: 4 units
This laboratory course provides a multifaceted view of the cell, with the opportunity for new discovery, through microscopic imaging of a cell’s response to environmental changes. We will identify endogenous products that undergo changes in expression or subcellular localization after simple environmental perturbations or drug treatments. Students will be trained in basic molecular biological methods, including recombinant DNA manipulation, and basics of functional genomic resources. Enrollment is limited to first year students in MCS. Special permission required. Corequisite: 03-121.

03-127 How Biological Experiments Work - A Project Course
Spring: 6 units
The goal of this course is to provide an understanding of the nuts and bolts of biological experimentation. We will discuss the molecular principles behind the wide variety of experiments that were used to discover how cells work. The first half of the class will be a lecture based discussion of key experimental methods used in biological research. The second half of the class will be dedicated to group projects that create “story boards” to explain in molecular terms how these experiments work. The story boards will be used by modelers at the Pittsburgh Supercomputing Center to generate high-end animations of these experimental processes. This will prepare students for working in research labs and biology courses beyond "Modern Biology". This course is limited to first year students in MCS. Special permission required. Prerequisite: 03-121.

03-201 Undergraduate Colloquium for Sophomores
Fall
The purpose of this seminar series is to update biology undergraduates about university and departmental functions, seminars, etc. that are pertinent or useful. In addition, research talks by faculty and undergraduates will be used to introduce students to the research being conducted in faculty laboratories. Additional topics may include graduate and medical school applications, career options, topics in the press, and important scientific discoveries.

03-202 Undergraduate Colloquium for Sophomores
Spring
03-203 Bench to Bedside: Process of Regenerative Therapeutics
Spring: 6 units
The goal of this mini-course is to provide students with a general background about the process of taking a regenerative therapeutic from the bench to the bedside. A target clinical indication will be identified, for example, enhanced fracture healing in the distal radius of a post-menopausal osteoporotic patient. We will produce a regenerative therapeutic for that clinical indication and progress through the bench to bedside design and development. Students will be exposed to the process where each component and the final product will be tested using standard in vitro and in vivo protocols. The goal will be accomplished through lectures and library assignments.

03-205 Electronics for Biological Applications
Intermittent: 4 units
This mini will cover basic concepts in electronics. The format for the course will be a weekly lecture and a hands-on laboratory project. We will introduce key concepts behind the electronic circuitry and instrumentation commonly found in a modern biology laboratory. The course will cover discrete electrical components, simple circuits, transistors, op-amps, digital electronics, bread-boarding, and the use of common analytical instruments. We will also show how concepts in electronics provide a valuable conceptual framework for understanding biological phenomena.

03-206 Biomedical Engineering Laboratory
Fall and Spring: 9 units
This laboratory course is designed to provide students with the ability to make measurements on and interpret data from living systems. The experimental modules reinforce concepts from 03-121 Introduction to Biomedical Engineering and expose students to four areas of biomedical engineering: biomedical signal and image processing, biomaterials, biomechanics, and cellular and molecular biotechnology. Several cross-cutting modules are included as well. The course includes weekly lectures to complement the experimental component. Prerequisites: 42-101 Introduction to Biomedical Engineering and 03-121 Modern Biology. Priority for enrollment will be given to students who have declared the Additional Major in Biomedical Engineering. Notes: This course number is reserved for students registered with the HPP program that, are CIT majors. If you require a biology lab for pre-health admissions requirements, please contact Dr. Conrad Zapanta and Dr. Maggie Braun (in the same email) for permission to register for 03-206 instead of 42-203. Priority for enrollment will be given to students who have declared the Additional Major in Biomedical Engineering.

03-210 Independent Study
Fall and Spring
Students will read papers from the original literature under the direction of a faculty member. Students will be required to demonstrate mastery of the readings by discussions with the sponsoring faculty member, oral presentations, or writing of one or more papers summarizing and extending the information in the readings. If appropriate, students may write a program(s) to satisfy this last requirement. A student may take this course only once. This is a mini format course. Special permission required.

03-230 Intro to Mammalian Physiology
Spring: 9 units
This course will survey the major organ systems, with an emphasis on cellular physiology and biochemistry. Current ideas of research and scientific controversy will also be presented. This course is intended to broaden students’ exposure to cellular processes in the context of complex organ systems. Corequisite: 03-121.

03-231 Biochemistry I
Fall: 9 units
This course provides an introduction to molecules and processes found in living systems. Amino acids, sugars, lipids and nucleotides and their corresponding higher structures, the proteins, polysaccharides, membranes and nucleic acids are studied. Kinetics and mechanisms of enzymes as well as elementary metabolic cycles and the energetics of biological systems are discussed. Prerequisite: 03-121.

03-232 Biochemistry I
Spring: 9 units
This course provides an introduction to the application of biochemistry to biotechnology. The functional properties of amino acids, nucleotides, lipids, and sugars are presented. This is followed by a discussion of the structural and thermodynamic aspects of the organization of these molecules into higher-order structures, such as proteins, nucleic acids, and membranes. The kinetics and thermodynamics of protein-ligand interactions are discussed for non-cooperative, cooperative, and allosteric binding events. The use of mechanistic and kinetic information in enzyme characterization and drug discovery are discussed. Topics pertinent to biotechnology include: antibody production and use, enzyme production in biochemical systems, expression of recombinant proteins, and methods of protein purification and characterization. The course is an alternate to 03-231. Prerequisites: 09-217 or 09-219 Corequisites: 09-106, 06-221.
03-240 Cell Biology
Spring: 9 units
This course provides descriptive information and mechanistic detail concerning key cellular processes in six areas: membrane function, protein targeting, signaling, cytoskeleton, cell division, and cell cell interactions. An attempt is made to introduce the methodology that was used to obtain this information and to discuss how our understanding of these processes relates to the treatment of human disease.
Prerequisites: 03-121 and (03-231 or 03-232).

03-250 Introduction Computational Biology
Spring: 12 units
This is a 12-unit class intended to provide a general introduction to computational tools for biology. The course is divided into two modules, which may be taken individually as courses 03-251/02-251 and 03-252/02-252. Module 1 covers computational molecular biology/genomics. It examines important sources of biological data, how they are archived and made available to researchers, and what computational tools are available to use them effectively in research. In the process, it covers basic concepts in statistics, mathematics, and computer science needed to effectively use these resources and understand their results. Specific topics covered include sequence data, searching and alignment, structural data, genome sequencing, genome analysis, genetic variation, gene and protein expression, and biological networks and pathways. Module 2 covers computational cell biology, including biological modeling and image analysis. It includes homeworks requiring use or modification of Matlab scripts. The modeling component includes computer models of population dynamics, biochemical kinetics, cell pathways, neuron behavior, and stochastic simulations. The imaging component includes basics of machine vision, morphological image analysis, image classification and image-derived models. This course is intended primarily for biological sciences or biomedical engineering majors at the undergraduate or graduate level who have had little or no prior experience with computer science or programming. Students may not take both 03-250/02-250 and either 03-251/02-251 or 03-252/02-252 for credit. Prerequisites: 03-121 or permission of the instructors.

03-251 Introduction to Computational Molecular Biology
Spring: 6 units
This 6-unit mini class intended to provide a general introduction to computational tools for biology with specific emphasis on molecular biology and genomics. Along with 03-252, it makes up one half of the full Introduction to Computational Biology, 03-250, although either half can be taken individually. 03-251 will examine important sources of biological data, how they are archived and made available to researchers, and what computational tools are available to use them effectively in research. In the process, it will cover basic concepts in statistics, mathematics, and computer science needed to effectively use these resources and understand their results. Specific topics to be covered include sequence data, searching and alignment, structural data, genome sequencing, genome analysis, genetic variation, gene and protein expression, and biological networks and pathways. This course is intended primarily for biological sciences or biomedical engineering majors at the undergraduate or graduate level who have had little or no prior experience with computer science or programming. Students may not take both 03-250/02-334 and either 03-251 or 03-252 for credit. Prerequisites: 03-121 or permission of the instructors.

03-252 Introduction to Computational Cell Biology
Spring: 6 units
This course presents an overview of important modeling and image analysis applications of computers to solve problems in biology. It is intended for students without computer programming experience. Major topics covered are biological imaging (digital image processing, morphological image analysis, image databases, image classification and image-derived models) and biological modeling and simulation (including computer models of population dynamics, biochemical kinetics, neuron behavior, cell pathways, and the cell cycle). Required recitations and homeworks consist of exercises requiring use of web site, software packages and simple Matlab scripts for these applications. Course grade is based on recitation participation, homework assignments based on the exercises, and mid-term and final exams. Note that this course is the second half of 03-250 (Introduction to Computational Biology) and that credit may not be given for both 03-250/02-250 and 03-252/02-252. Prerequisites: 03-121 or permission of instructor.

03-301 Undergraduate Colloquium for Juniors
Fall
The purpose of this seminar series is to update biology undergraduates about university and departmental functions, seminars, etc. that are pertinent or useful. In addition, research talks by faculty and undergraduates will be used to introduce students to the research being conducted in faculty laboratories. Additional topics may include graduate and medical school applications, career options, topics in the press, and important scientific discoveries.

03-302 Undergraduate Colloquium for Juniors
Spring

03-315 Magnetic Resonance Imaging in Neuroscience
Intermittent: 9 units
The course is designed to introduce students to the fundamental principles of magnetic resonance imaging (MRI) and its application in neuroscience. MRI is emerging as the preeminent method to obtain structural and functional information about the living human brain. This methodology has helped to revolutionize neuroscience and the study of human cognition. The specific topics covered in this course will include: introduction to spin gymnastics, survey of imaging methods, structural brain mapping, functional MRI (fMRI), and MR spectroscopy (MRS). Approximately, one third of the course will be devoted to introductory concepts of magnetic resonance, another third to the discussion of MRI methods, and the remaining third will cover a broad range of neuroscience applications. Guest lectures will be incorporated into the course from neuroscientists and psychologists who use MRI in their own research.
Prerequisites: 03-121 and (21-117 or 21-121 or 21-122).

03-325 Evolution
Fall: 9 units
Evolution is the unifying theory of biology. This course will provide a broad coverage of the concepts of evolution but will especially focus on the molecular basis of evolutionary change. Topics will include (i) the history of evolutionary theories, before and after Darwin, and the evidence for evolution; (ii) the origins and radiations of key phylogenetic nodes including, life, multicellularity, animals, and mammals (iii) adaptation, fitness, variation and natural selection, (iv) evolution and development of animal body plans, and (v) cis-regulatory evolution and gene regulatory networks. The main objective of the course is for students to gain a thorough understanding of the evolutionary, molecular basis of the diversity and origins of life. Additionally, by the end of the course students should have gained a deeper understanding of all areas of biology through an appreciation of underlying historical processes.
Prerequisite: 03-121
Corequisite: 03-330.

03-326 Evolution of Regulatory Genomics
Fall: 4.5 units
This course will examine the processes by which genomes evolve and how genetic variation leads to phenotypic diversity. An introduction to gene regulation, how the genome controls development, comparisons of development and the phenotypic diversity in animals will be provided. Then we will consider ways in which genomes evolve, followed by in depth coverage of how gene regulation has evolved (focusing on cis regulatory evolution and non-coding RNA regulatory evolution). Finally the concept of gene regulatory network control of development and understanding evolution as change in these networks will be examined. Concepts and specific examples will come through reading of primary literature and selected readings from advanced texts.
Prerequisite: 03-231
Corequisite: 03-330.

03-327 Phylogenetics
Fall: 4.5 units
An advanced introduction to theory and practice of phylogenetic analysis (evolutionary tree reconstruction), with a focus on molecular evolution. Basic concepts will be introduced in the context of a historical survey of phylogeny reconstruction. A comprehensive introduction to phylogenetic methods will be presented, including data selection, multiple sequence alignment, character weighting, distance matrices, sequence evolution models, and the four major approaches to phylogeny reconstruction: Parsimony, Distance matrix, Maximum likelihood, and Bayesian analysis. Sources of error and methods for assessing the reliability of phylogenetic inference will be discussed. We will cover additional topics as time allows, such as phylogenetic hypothesis testing, genome scale approaches, the interface between phylogenetics and population genetics, gene tree reconciliation, horizontal gene transfer, and phylogenetic networks.
Prerequisites: 03-231 or 03-232 or 03-310.
03-330 Genetics
Fall: 9 units
The mechanisms of transmission of inherited traits in viruses, bacteria, fungi, plants and animals are discussed. Molecular mechanisms of gene expression and gene regulation are analyzed. Recombinant DNA and its applications in genetic analysis, biotechnology, forensics, agriculture, medicine, and the pharmaceutical industry are presented. Special topics in human genetics are considered, such as the genetics of cancer. Principles and methods for the study of developmental genetics, population genetics and complex traits are also introduced.
Prerequisites: 03-231 or 03-232.

03-342 Introduction to Biological Laboratory Practices
Fall: 1 unit
This course is designed for students in the BS in Computational Biology degree program. It will be taught as a first mini as a required co-requisite for 03-343. Experimental Genetics and Molecular Biology and is designed to be an introduction to basic laboratory practices. The course will introduce biological and chemical safety training and basic laboratory practices. Techniques of solution preparation and titration, pipetting, UV/VIS spectroscopy, and quantitation of biological compounds will be covered.
Corequisite: 03-343.

03-343 Experimental Techniques in Molecular Biology
Fall: 12 units
This laboratory course is designed to teach experimental methods of modern biology. Experiments in microbial genetics, molecular biology and eukaryotic genetics are performed. Emphasis is placed on understanding and applying the biological principles of each experiment. The course is designed to be taken during the junior year and is intended to prepare students for undergraduate research. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.
Prerequisites: (03-231 or 03-232) and 09-222
Corequisite: 03-330.

03-344 Experimental Biochemistry
Spring: 12 units
This course is designed to be taken as a sequel to 03-343. Experiments cover a variety of methods for investigating the structure and function of biological molecules. Experimental methods with proteins, enzyme kinetics, lipids, spectroscopy, and isolation and quantization of biological molecules are covered. During several experiments, students design their own projects. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.
Prerequisites: (03-231 or 03-232) and 03-343.

03-345 Experimental Cell and Developmental Biology
Spring: 12 units
This laboratory is designed to teach concepts and experimental methods in cell and developmental biology. Students work with a variety of organisms to examine how cells traverse development from rapidly dividing, undifferentiated cells, through cell commitment and the establishment of spatial and temporal patterns of gene expression, to the specific characteristics and responses of terminally differentiated cells. The course makes extensive use of video microscopy with phase contrast, DIC and fluorescence microscopes. Biochemical, immunological and molecular biological techniques are used to probe the molecules and processes of cells undergoing development. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.
Prerequisites: (03-231 or 03-232) and 03-240 and 03-330 and 03-343
Corequisite: 03-350.

03-350 Developmental Biology
Spring: 9 units
Developmental biology is the study of how organisms arise from a single cell — the fertilized egg. The molecular pathways that control development also underlie many human diseases. Developmental biology encompasses stem cell biology, cell-cell signaling, regulation of gene expression, gene networks, morphogenesis, and cell/tissue differentiation. This course serves as an introduction to the major concepts, experimental methodologies, research questions, and model organisms in developmental biology.
Prerequisite: 03-240.

03-362 Cellular Neuroscience
Spring: 9 units
Modern neuroscience is an interdisciplinary field that seeks to understand the function of the brain and nervous system. This course provides a comprehensive survey of cellular and molecular neuroscience ranging from molecules to simple neural circuits. Topics covered will include the properties of biological membranes, the electrical properties of neurons, neural communication and synaptic transmission, mechanisms of brain plasticity and the analysis of simple neural circuits. In addition to providing information the lectures will describe how discoveries were made and will develop students’ abilities to design experiments and interpret data.
Prerequisite: 03-121.

03-363 Systems Neuroscience
Fall: 9 units
Modern neuroscience is an interdisciplinary field that seeks to understand the function of the brain and nervous system. This course provides a comprehensive survey of systems neuroscience, a rapidly growing scientific field that seeks to link the structure and function of brain circuitry to perception and behavior. This course will explore brain systems through a combination of classical, Nobel prize-winning data and cutting edge primary literature. Topics will include sensory systems, motor function, animal behavior and human behavior in health and disease. Lectures will provide fundamental information as well as a detailed understanding of experimental designs that enabled discoveries. Finally, students will learn to interpret and critique the diverse and multimodal data that drives systems neuroscience.
Prerequisites: 03-121 or 03-362 or 03-762.

03-364 Developmental Neuroscience
Fall: 9 units
This course examines the principles that govern the developmental assembly of a complex nervous system. Topics range from the earliest steps of induction of neural tissue and birth of neurons to the plasticity within developing circuits and the development of behavior. By the end of this course students should be able to describe the major steps in neural development and to interpret key experiments using vertebrate and invertebrate models have helped to elucidate these steps. This course is taught on the University of Pittsburgh campus by faculty from Carnegie Mellon and Pitt.
Prerequisites: 03-240 or 03-362 or 03-363.

03-380 Virology
Fall: 9 units
The concepts and methods of virology are covered, with emphasis on animal viruses, within the framework of cell biology, genetics, molecular biology, immunology, pathology, and epidemiology. The strategies that a wide variety of different DNA and RNA viruses, including some of the emerging ones, use to replicate and express their genomes during infection of host cells will be examined in some detail. The effects that viruses inflict on these cells will also be examined, as will some of the host cell responses generated by such virus-cell interactions, including interferon induction, the antiviralresponse generated by interferon, and oncogenic transformation. In addition, an overview of procedures used for prevention and treatment of viral diseases via vaccines and antiviral drugs, respectively, will be presented, as will a brief discussion of viroids and prions, and the characteristics of these agents which distinguish them from viruses.
Prerequisite: 03-240
Corequisite: 03-330.

03-390 Molecular and Cellular Immunology
Spring: 9 units
This course offers the student a comprehensive view of modern immunology at the molecular and cellular level. The first half of the course presents the fundamentals of immunology, beginning with innate immunity, followed by a discussion of the structure and function of important molecules in the immune system, such as antibodies, major histocompatibility antigens, complement, and the T-cell receptor. This portion of the course is concluded with a discussion of the development and function of the cellular immune response. The second half of the course is focused on applied immunology and discusses hypersensitivity, autoimmunity, immunodeficiencies, tumor immunology, infectious disease, and transplantation immunology. Presentations at the end of the course provide an opportunity for the student to explore additional topics in contemporary immunology.
Prerequisites: (03-231 or 03-232) and 03-240.
03-391 Microbiology: Biophysics and Molecular Biology
Spring: 9 units
This course will provide an introduction to microorganisms, with an emphasis on their scientific, societal, and global impact. Specific topics include basic principles of microbiology, introduction to molecular biology, genetics of microorganisms, microbial genomics and diversity, eukaryotic microorganisms, microbial metabolism, biotechnology, infectious diseases, and antibiotic compounds. Prerequisites: 03-231 or 03-232.

03-392 Microbiology Laboratory
Spring: 6 units
In this course, you will gain experimental experience with key concepts in microbiology (eg: taxonomy, antibiotic resistance, changes in morphology, secretion of metabolites into media, plasmids, medical implications, etc.); however, you will explore these concepts in the lab by using both standard and nonstandard state-of-the-art equipment (eg: flow cytometer, atomic force microscope, fluorescence/bright-field/phase-contrast light microscope, light scattering, etc.). Corequisite: 03-391.

03-401 Undergraduate Colloquium for Seniors
Fall
The purpose of this seminar series is to update biology undergraduates about university and departmental functions, seminars, etc. that are pertinent or useful. In addition, research talks by faculty and undergraduates will be used to introduce students to the research being conducted in faculty laboratories. Additional topics may include graduate and medical school applications, career options, topics in the press, and important scientific discoveries.

03-402 Undergraduate Colloquium for Seniors
Spring

03-410 Special Topics in Biology
All Semesters
Special Topics in Biological Sciences.

03-411 Topics in Research
Fall
During the year students attend and submit brief summaries of weekly seminars given by outside speakers or members of the Biology Department on current research topics in modern biology; some seminars outside of the department may be substituted.

03-412 Topics in Research
Spring
During the year students attend and submit brief summaries of weekly seminars given by outside speakers or members of the Biology Department on current research topics in modern biology. Some seminars outside of the department may be substituted.

03-439 Introduction to Biophysics
Fall: 9 units
Description: This intermediate level course is primarily offered to Physics and Biology undergrads (junior/senior) and provides a modern view of molecular and cellular biology as seen from the perspective of physics, and quantum mechanics through the analytical tools of physics. This course will not review experimental biophysical techniques (which are covered, e.g., in 03-871). Rather, physicists will learn what sets “bio” apart from the remainder of the Physics world and how the apparent dilemma that the existence of life represents to classical thermodynamics is reconciled. They will also learn the nomenclature used in molecular biology. In turn, biologists will obtain (a glimpse of) what quantitative tools can achieve beyond the mere collecting and archiving of facts in a universe of observations: By devising models, non-obvious quantitative predictions are derived which can be experimentally tested and may lead to theories that connect vastly different, apparently unrelated phenomena. One major goal is then to merge the two areas, physics and biology, in a unified perspective.
Spring: 9 units
Prerequisites: 03-231 or 03-232.

03-441 Topics in Molecular Biology
Spring
Prerequisites: 03-231 or 03-232.

03-442 Molecular Biology
Fall: 9 units
The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms including yeast, flies, worms, mice, humans, and plants. Topics discussed include: genomics, proteomics, and functional genomics, and the action of molecular motors. This course is particularly aimed at students who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological research. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work includes four to six problem sets, one midterm and final exam. Prerequisites: 03-121 and 15-122.

03-445 Undergraduate Research
Fall and Spring
Students may investigate research problems under the supervision of a faculty advisor. Permission of a faculty advisor required.

03-511 Computational Molecular Biology and Genomics
Fall: 9 units
An advanced introduction to computational molecular biology, using an applied algorithms approach. The first part of the course will cover established algorithmic methods, including pairwise sequence alignment and dynamic programming, multiple sequence alignment, fast database search heuristics, hidden Markov models for molecular motifs and phylogeny reconstruction. The second part of the course will explore emerging computational problems driven by the newest genomic research. Course work includes four to six problem sets, one midterm and final exam. Prerequisites: 03-121 and 15-122.

03-512 Computational Methods for Biological Modeling and Simulation
Fall: 9 units
This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological research. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work includes problems sets with significant programming components and independent or group final projects. Prerequisites: 03-121 and 15-122.

03-534 Biological Imaging and Fluorescence Spectroscopy
Spring: 9 units
This course covers principles and applications of optical methods in the study of structure and function in biological systems. Topics to be covered include: absorption and fluorescence spectroscopy; interaction of light with biological molecules, cells, and systems; design of fluorescent probes and optical biosensor molecules; genetically expressible optical probes; photochemistry; optics and image formation; transmitted-light and fluorescence microscope systems; laser-based systems; scanning microscopes; electronic detectors and cameras; image processing; multi-mode imaging systems; microscopy of living cells; and the optical detection of membrane potential, molecular assembly, transcription, enzyme activity, and the action of molecular motors. This course is particularly aimed at students in science and engineering interested in gaining in-depth knowledge of modern light microscopy.
Prerequisites: 03-231 or 03-232 and 03-240 and 09-218 and (09-144 or 09-214).

03-545 Honors Research
Spring
This semester of research consists primarily of research and preparation of an acceptable written thesis. Oral presentation and defense of the thesis research will be required. This course ordinarily will be taken in the second semester of the senior year. Permission of the research advisor required. Prerequisite: 03-445.

03-601 Computational Biology Internship
All Semesters
This course allows a student to gain computational biology experience in a “real-world” setting. Internships vary widely in scope, but common to all is the chance to practice computational biology skills acquired in the classroom. Typically, students seek and secure their own internships.
03-620 Techniques in Electron Microscopy  
Spring: 9 units  
This course is designed to teach basic methods in transmission electron microscopy to graduate and undergraduate students. Sophomores with an interest in electron microscopy are encouraged to enroll, and will have the option and opportunity to utilize their skills in various laboratories during their junior or senior year. The course will be offered once each year, during the spring semester. Course enrollment will be limited to 4-6 students. Preferential enrollment will be given to graduate students and undergraduate students who have demonstrated a need for this technique in their research. The class will include one hour of lecture and 4 hours of laboratory each week (some additional laboratory time outside of the scheduled laboratory time is required). Students will learn basic methods in specimen preparation for both transmission and scanning electron microscopy (fixation, embedding and ultramicrotomy, drying and metal coating) and will be trained in the operation of both the Hitachi 7100 and 2460N electron microscopes. Lectures and laboratories during the last few weeks of the semester will introduce the students to special techniques (e.g. immunoelectron microscopy, cryoultramicrotomy, freeze substitution, variable pressure SEM, etc.) and will allow them to work with samples from their own research. Experimentation using living organisms and/or their tissues, cells or molecules is a component of this course. Special permission is required.

03-700 MS Thesis Research  
All Semesters  
A student enrolled in this course conducts an independent investigation on a project in a faculty advisor’s lab. The project is selected from a major area of research study with the advice and approval of the faculty advisor. This course is required of students who are enrolled in the Master of Science program and wish to write and defend a thesis.

03-710 Computational Biology  
Spring: 12 units  
This course covers a range of applications of computers to solve problems in biology and medicine. Specific topics covered are computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of neuron behavior, biochemical kinetics, and simulation of mutation), and biological imaging. Course work will include use of software packages for these applications, reading of scientific papers, and programming assignments. Students may use one of the following courses for credit, 03-310, 03-311, 03-510 or 03-710. Prerequisites: 03-121 and (15-200 or 15-211).

03-711 Computational Molecular Biology and Genomics  
Fall: 12 units  
An advanced introduction to computational molecular biology, using an applied algorithms approach. The first part of the course will cover established algorithmic methods, including pairwise sequence alignment and dynamic programming, multiple sequence alignment, fast database search heuristics, hidden Markov models for molecular motifs and phylogeny reconstruction. The second part of the course will explore emerging computational problems driven by the newest genomic research. Course work includes four to six problem sets, one midterm and final exam. Prerequisites: 03-121 and 15-212.

03-712 Computational Methods for Biological Modeling and Simulation  
Spring: 12 units  
This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological applications. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work will include problems sets with significant programming components and independent or group final projects. Prerequisites: 03-121 and 15-212.

03-713 Bioinformatics Data Integration Practicum  
Spring: 6 units  
This course will provide a practical experience in integration of bioinformatics data of diverse types in collaboration with a pharmaceutical company or biotechnology company. At the beginning of the semester, students will be presented with a description of the problem and data sets. During the semester students will work as part of independent teams to design, implement and evaluate an appropriate data integration system (with the opportunity for interaction with the company developers for advice and feedback). The course grade will be based on an oral presentation of the developed software system and a written report describing its development and evaluation. Selected students will have the opportunity to present their work to the company. Prerequisites: (03-310 or 03-311 or 03-510) and 15-211.

03-714 Computational Structural Biology  
12 units

03-715 Computational Genomics  
Spring: 12 units  
Dramatic advances in experimental technology and computational analysis are fundamentally transforming the basic nature and goal of biological research. The emergence of new frontiers in biology, such as evolutionary genomics and systems biology is demanding new methodologies that can confront quantitative issues of substantial computational and mathematical sophistication. In this course we will discuss classical approaches and latest methodological advances in the context of the following biological problems: 1) Computational genomics, focusing on gene finding and sequence evolution; 2) Analysis of high throughput biological data, such as gene expression data, focusing on issues ranging from data acquisition to pattern recognition and classification; 3) Molecular and regulatory evolution, focusing on phylogenetic inference and regulatory network evolution; 4) Systems biology, concerning how to combine sequence, expression and other biological data sources to infer the structure and function of different systems in the cell. From the computational side this course focuses on modern machine learning methodologies for computational problems in molecular biology and genetics, including probabilistic modeling, inference and learning algorithms, pattern recognition, data integration, time series analysis, active learning, etc.

03-726 Evolution of Regulatory Genomics  
Fall: 6 units  
This course will examine the processes by which genomes evolve and how this genetic variation leads to phenotypic diversity. An introduction to gene regulation, how the genome controls development, comparisons of development and the phenotypic diversity in animals will be provided. Then we will consider ways in which genomes evolve, followed by in depth coverage of how gene regulation has evolved (focus on regulatory evolution and non-coding RNA regulatory evolution). Finally the concept of gene regulatory network control of development and understanding evolution as change in these networks will be examined. Concepts and specific examples will come from discussion of primary literature and selected readings from advanced texts. Grading will be based on written assignments from readings of literature, participation in class discussion, and two in class exams. The graduate level course (03-726) will in addition require a term paper based on thorough and critical reading of primary literature focused on one of the general topics presented in the course. Corequisite: 03-330.

03-727 Phylogenetics  
Fall: 6 units  
An advanced introduction to theory and practice of phylogenetic analysis (evolutionary tree reconstruction), with a focus on molecular evolution. Basic concepts will be introduced in the context of a historical survey of phylogeny reconstruction. A comprehensive introduction to phylogenetic methods will be presented, including data selection, multiple sequence alignment, character state data versus distance matrices, sequence evolution models, and the four major approaches to phylogeny reconstruction: Parsimony, Distance matrix, Maximum likelihood, and Bayesian analysis. Sources of error and methods for assessing the reliability of phylogenetic inference will be discussed. We will cover additional topics as time allows, such as phylogenetic hypothesis testing, genome scale approaches, the interface between phylogenetics and population genetics, gene tree reconciliation, horizontal gene transfer, and phylogenetic networks. Course work will include readings from textbooks and seminal articles from the primary literature, problem sets from final exam and possibly in class exams. Students in 03-727 will also carry out a major data analysis project, intended to familiarize the student with the practical application of principles taught in class. A short paper summarizing the results of this project will be required.
03-730 Advanced Genetics
Spring: 12 units
This course considers selected current topics in genetics at an advanced level. Emphasis is on classroom discussion of research papers. Topics change yearly. Recent topics have included nucleocytoplasmic trafficking of RNA in yeast, genome imprinting in mammals, genetics of learning and memory in Drosophila, and viral genomics.
Prerequisites: 03-330 and (03-442 or 03-742).

03-738 Physical Biochemistry
Fall: 12 units
Prerequisites: (03-231 or 03-232) and (09-214 or 09-345).

03-740 Advanced Biochemistry
Spring: 12 units
This is a special topics course in which selected topics in biochemistry will be analyzed in depth with emphasis on class discussion of papers from the recent research literature. Topics change yearly. Recent topics have included single molecule analysis of catalysis and conformational changes; intrinsically disordered proteins; cooperative interactions of aspartate transcarbamoylase; and the mechanism of ribosomal protein synthesis.

03-741 Advanced Cell Biology
Spring: 12 units
This course covers fourteen topics in which significant recent advances or controversies have been reported. For each topic there is a background lecture by the instructor, student presentations of the relevant primary research articles and a general class discussion. Example topics are: extracellular matrix control of normal and cancer cell cycles, force generating mechanisms in trans-membrane protein translocation, signal transduction control of cell motility, and a molecular mechanism for membrane fusion.
Prerequisites: (03-231 or 03-232) and 03-240.

03-742 Molecular Biology
Fall: 12 units
The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms including yeast, flies, worms, mice, humans, and plants. Topics discussed include (1) genomics, proteomics, and functional proteomics and (2) control of gene expression at the level of transcription of mRNA from DNA, splicing of pre-mRNA, export of spliced mRNA from the nucleus to the cytoplasm, and translation of MrNA.
Prerequisite: 03-330.

03-744 Membrane Trafficking
Spring: 9 units
While the focus of this course is to analyze membrane/protein traffic along both the biosynthetic and endocytic pathways, our general goal is to teach students how to read and interpret the literature. In particular, we emphasize the conclusions and discuss their validity. The course is updated each year to include topics in which new and interesting developments have occurred. Emphasis is placed on how membrane traffic is regulated and where applicable how it is disrupted or subverted during disease processes. The course is of general interest to students, fellows, and faculty interested in cell biology, immunology, neurobiology, pharmacology and virology.
Prerequisite: 03-240.

03-745 Core Course in Biochemistry
Fall: 6 units
This course is designed to provide first year doctoral students in the Department of Biological Sciences with a broad foundation in biochemistry and biophysical techniques. Topics include protein structure, enzymology, and methods to characterize protein structure and function. Students will be evaluated throughout the course, and with a final exam.

03-746 Core Course in Cell Biology
Fall: 6 units
This course is designed to provide first year doctoral students in the Department of Biological Sciences with a broad foundation in cell biology. Topics include, but are not limited to, intracellular trafficking, signal transduction, the cytoskeleton, the cell cycle, and cell-cell interactions. This is a lecture-based course and will include some discussion of the primary literature. Students will be evaluated weekly, and with a final exam. Enrollment requires instructor permission.

03-750 Graduate Seminar
Fall and Spring: 1 unit
Each semester, all Department of Biological Sciences graduate students are required to register for and attend the weekly departmental Research Seminar (03-750, 1 unit). Graduate students are strongly urged to meet the speakers to broaden their knowledge of cutting-edge biological science, to discuss career paths and strategies and to make useful contacts; the faculty host can arrange group meetings for interested students.

03-751 Advanced Developmental Biology
Fall: 12 units
This course examines current topics in developmental biology at an advanced level. The course is team-taught by faculty from Carnegie Mellon University, the University of Pittsburgh Department of Biological Sciences, and the University of Pittsburgh Medical School. Each year several areas of current research are examined. Previous topics have included pattern formation, molecular signaling pathways, morphogen gradients, cell movements, and stem cells. Emphasis is on critical reading of original research papers and classroom discussion, with supporting lectures by faculty.
Prerequisite: 03-350.

03-755 Graduate Research Seminar
Fall and Spring: 3 units
Each semester, all Department of Biological Sciences graduate students are required to register for and attend the weekly departmental Journal Club (Graduate Research Seminar 03-755, 3 units) during which students and faculty members give 25-minute presentations. Second-year students present a research paper or topic from the literature, and more senior students present their research results; typically, graduate students give four Journal Club presentations during their time in the department. Each succeeding year, those students who speak at the Departmental Retreat or who are graduating by May of their fifth year are not required to present a Journal Club that year.

03-760 Membrane Biochemistry and Biophysics
All Semesters: 9 units

03-761 Neural Plasticity
Spring: 9 units
Neural plasticity underlies the capacity of the central nervous system to encode new information, develop new abilities and adapt to the environment. Plasticity is required for learning and is modulated during development and by disorders of the brain. Recent advances in experimental methodology have led to new insights on the biological mechanisms underlying neural plasticity. The topics if the papers chosen for review will center on recent experimental and theoretical studies of topics such as synaptic plasticity, developmental and activity dependent changes in sensory and motor maps.
Prerequisite: 03-360.

03-762 Advanced Cellular Neuroscience
Spring: 12 units
This course is a graduate version of 03-362. Students will attend the same lectures as the students in 03-362, plus an additional once weekly meeting. In this meeting topics covered in the lectures are addressed in greater depth, often through discussions of papers from the primary literature. Students will read and be expected to have an in depth understanding of several classic papers from the literature including work by Hodgkin and Huxley on action potentials and by Katz and Eccles on synaptic transmission. Generation and use of genetically modified animals also will be discussed. Performance in this portion of the class will be assessed by supplemental exam questions.

03-763 Advanced Systems Neuroscience
Fall: 12 units
This course is a graduate version of 03-363. Students will attend the same lectures as the students in 03-363, plus an additional once weekly meeting. In this meeting, topics covered in the lectures will be addressed in greater depth, often through discussions of papers from the primary literature. Students will read and be expected to have an in depth understanding of several classic papers from the literature as well as current papers that illustrate cutting edge approaches to systems neuroscience or important new concepts. Use of animals as research model systems will also be discussed. Performance in this portion of the class will be assessed by supplemental exam questions as well as by additional homework assignments.
Prerequisites: 03-121 or 03-362 or 03-762.
Biomedical Engineering Courses

42-101 Introduction to Biomedical Engineering
Fall and Spring: 12 units
This course will provide exposure to the concepts and principles of biomedical engineering. Topics covered include: the roles and responsibilities of biomedical engineers, the communication of information to regulatory agencies, the design of medical devices, and the ethical considerations of biomedical engineering.

42-200 Sophomore BME Research Project
Fall and Spring: 9 units
Research projects for sophomores under the direction of a regular or adjunct BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects provided that a regular or adjunct BME faculty member agrees to serve as a co-advisor. The nature of the project, the number of units, and the criteria for grading are to be determined by the student and the research advisor.

42-300 Junior BME Research Project
Fall and Spring: 9 units
Research projects for juniors under the direction of a regular or adjunct BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects provided that a regular or adjunct BME faculty member agrees to serve as a co-advisor.

42-871 Structural Biophysics
Fall: 12 units
The physical properties of biological macromolecules and the methods used to analyze their structure and function are discussed. Topics covered include: protein architecture and folding; nucleic acid structures and energetics; structure determination by X-ray crystallography and NMR; biological spectroscopy with emphasis on absorption, fluorescence, NMR spectroscopy; other methods to characterize proteins and protein-ligand interactions, such as mass spectrometry, calorimetry, and surface plasmon resonance. Sufficient detail is given to allow the student to critically evaluate the current literature.

42-899 Doctoral Thesis Research
All Semesters
Doctoral Thesis Research consists of an independent investigation on a project selected from a major area of research study with the advice and approval of the faculty advisor.

42-101 Professional Issues in Biomedical Engineering
Fall and Spring: 3 units
This course exposes students to many of the issues that biomedical engineers face. It provides an overview of professional topics including bioethics, regulatory issues, communication skills, teamwork, and other contemporary issues.

42-201 Cellular and Molecular Biotechnology
Fall: 9 units
This course will provide students with an introduction to biotechnology in an engineering context. The focus will be on using microorganisms to prepare therapeutically relevant biomolecules. Topics to be covered include cellular and microbial metabolism, recombinant DNA methodologies, bioreactor design, protein separation and purification, and systems approaches to biotechnology.

42-202 Biomedical Engineering Laboratory
Fall and Spring: 9 units
This laboratory course is designed to provide students with the ability to make measurements on and interpret data from living systems. The experimental modules reinforce concepts from 42-101 Introduction to Biomedical Engineering and expose students to four areas of biomedical engineering: biomedical signal and image processing, biomaterials, biomechanics, and cellular and molecular biotechnology.

42-301 Introduction to Biomechanics
Fall: 9 units
This course provides a general survey of the application of solid mechanics and rigid body dynamics to the study of the human cardiovascular and musculoskeletal systems. The mechanical properties and behavior of heart, blood vessel, bone, muscle and connective tissues are discussed and experimental results are presented through readings from reports in recent journals and the relevance of these results to the solution of unsolved problems is highlighted. The development of appropriate models for particular problems is also considered.

42-302 Magnetic Resonance Imaging in Neuroscience
Fall: 9 units
This course introduces students to magnetic resonance imaging of the brain. Topics include: the physics of MRI, pulse sequence design, and applications of MRI to human and animal brain imaging. Special emphasis will be placed on functional MRI (fMRI) and diffusion tensor imaging (DTI).

42-303 Virology
All Semesters: 9 units
The concepts and methods of virology are covered, with emphasis on animal viruses, within the framework of cell biology, genetics, molecular biology, immunology, pathology, and epidemiology. The emphasis will be on the unique processes for replication and expression of viral genomes and the pathogenic effects of these genetic units.

42-304 Molecular Biology of Cancer
Fall: 9 units
This course will expose students to the molecular basis of cancer, including the genetic alterations that lead to cancer, the interactions between tumors and the immune system, and the mechanisms of drug resistance. The course will also cover the latest developments in cancer research and therapy.

42-305 Molecular Genetics of Cancer
Fall: 9 units
The molecular basis of cancer will be covered in depth, with an emphasis on the genetic alterations that lead to cancer and the mechanisms of drug resistance. The course will also cover the latest developments in cancer research and therapy.

42-306 Cancer Cell Biology
Fall: 9 units
This course will expose students to the molecular and cellular mechanisms that are involved in the development and progression of cancer. Topics covered will include cell cycle regulation, apoptosis, and angiogenesis.

42-307 Cancer Immunology
Fall: 9 units
This course will introduce students to the immunology of cancer, including the role of the immune system in the prevention and treatment of cancer.

42-308 Cancer Therapy
Fall: 9 units
This course will expose students to the various therapeutic approaches used to treat cancer, including chemotherapy, radiation therapy, and immunotherapy.

42-309 Cancer Epidemiology
Fall: 9 units
This course will introduce students to the epidemiology of cancer, including the risk factors for cancer and the impact of cancer on society.

42-310 Cancer Genomics
Fall: 9 units
This course will introduce students to the field of cancer genomics, including the use of DNA sequencing to identify genetic alterations associated with cancer.

42-311 Cancer Epigenetics
Fall: 9 units
This course will introduce students to the field of cancer epigenetics, including the role of DNA methylation and histone modification in the development and progression of cancer.

42-312 Cancer Stem Cells
Fall: 9 units
This course will introduce students to the role of cancer stem cells in the development and progression of cancer.

42-313 Cancer Metastasis
Fall: 9 units
This course will introduce students to the mechanisms of cancer metastasis, including the role of the immune system in the prevention of metastasis.

42-314 Cancer Hallmarks
Fall: 9 units
This course will introduce students to the hallmarks of cancer, including the ability of cancer cells to evade apoptosis, to sustain proliferation signals, to grow without limits in soft agar, to induce angiogenesis, to activate invasion and metastasis, to reprogram the metabolism of the cancer cell, and to escape immune destruction.

42-315 Cancer Hallmarks
Fall: 9 units
This course will introduce students to the hallmarks of cancer, including the ability of cancer cells to evade apoptosis, to sustain proliferation signals, to grow without limits in soft agar, to induce angiogenesis, to activate invasion and metastasis, to reprogram the metabolism of the cancer cell, and to escape immune destruction.

42-316 Cancer Hallmarks
Fall: 9 units
This course will introduce students to the hallmarks of cancer, including the ability of cancer cells to evade apoptosis, to sustain proliferation signals, to grow without limits in soft agar, to induce angiogenesis, to activate invasion and metastasis, to reprogram the metabolism of the cancer cell, and to escape immune destruction.

42-317 Cancer Hallmarks
Fall: 9 units
This course will introduce students to the hallmarks of cancer, including the ability of cancer cells to evade apoptosis, to sustain proliferation signals, to grow without limits in soft agar, to induce angiogenesis, to activate invasion and metastasis, to reprogram the metabolism of the cancer cell, and to escape immune destruction.

42-318 Cancer Hallmarks
Fall: 9 units
This course will introduce students to the hallmarks of cancer, including the ability of cancer cells to evade apoptosis, to sustain proliferation signals, to grow without limits in soft agar, to induce angiogenesis, to activate invasion and metastasis, to reprogram the metabolism of the cancer cell, and to escape immune destruction.
42-400 Senior BME Research Project  
Fall and Spring  
Research projects for seniors under the direction of a regular or adjunct BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects provided that a regular or adjunct BME faculty member agrees to serve as a co-advisor. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the research advisor. The agreement should be summarized in a two-page project description with sign-off by the research advisor and a copy submitted for review and filing with the BME Department. A final written report or oral presentation of the results is required. Units may vary from 3 to 12 according to the expected time commitment, with one unit corresponding to 1 hour of research per week.

42-401 Foundation of BME Design  
Fall: 3 units  
This course introduces Biomedical Engineering students to the design of useful biomedical products. Students will learn to identify product needs, how to specify problem definitions and to use project management tools. Methods to develop creativity in design will be introduced. Students will form project teams and select a project to be completed during the following semester in 42-402. This course culminates in the completion of a design brief. Prerequisite: Senior standing in Biomedical Engineering. Co-requisite: 42-101.

42-402 BME Design Project  
Spring: 9 units  
This course focuses on integrated product development for biomedical products. Teams will consist of a variety of Biomedical Engineering students. The course consists of modules including the development of a project plan, background research, hazard analysis, setting product specifications based on user requirements, detailed design and analysis, prototype development and final documentation and presentation. Additional relevant professional development topics are also covered, including technical public speaking, proposal preparation, personal time management, and other topics. All products developed will respond to the needs of appropriate market segments; resulting products will be deemed safe, effective, useful, usable and desirable by those segments. Students will produce a form model, functional prototype, marketing plan, and manufacturing plan of their product. Prerequisite: 42-401 (3 units, Fall) Foundations of Biomedical Engineering Design  
Prerequisite: 42-401.

42-411 Introduction to Molecular Biomaterials  
Fall: 9 units  
This course covers structure-processing-property relationships in biomaterials for use in medicine. This course will focus on a variety of materials including natural biopolymers, synthetic polymers, and soft materials with additional treatment of metals and ceramics. Topics include considerations in molecular design of biomaterials, understanding cellular aspects of tissue-biomaterials interactions, and the application of bulk and surface properties in the design of medical devices. This course will discuss practical applications of these materials in drug delivery, tissue engineering, biosensors, and other biomedical technologies. Cross-listed with 27-411.

42-419 Biomaterial/Host Interactions  
Fall: 12 units  
The goal of this course is to provide students with hands-on experience in investigating host responses to materials. Implant studies of tissue-engineering materials will be performed using animal models in a laboratory setting, and students will gain experience in the analysis of host responses. Material biocompatibility and tissue regeneration will be addressed. Characterization techniques will include histology, real-time polymerase chain reaction, and immunofluorescent staining. Laboratory work will be complemented with lectures. Prerequisite: junior or senior standing in Biomedical Engineering, or consent of instructor.

42-426 Biosensors and BioMEMS  
Intermittent: 9 units  
This course emphasizes the principles of biomolecule-based sensing, including molecular recognition, biomolecular binding kinetics and equilibrium; methods of detection and signal transduction, including optical, colorimetric, fluorescence, potentiometric, and gravimetric techniques; statistical principles of high throughout screening; microfluidic and microarray device design principles and fabrication technologies; molecular motors. Prerequisites: 03-231 OR 03-232 Biochemistry. Prerequisite: 03-232.

42-431 Introduction to Biomedical Imaging and Image Analysis  
Fall: 12 units  
This course gives an overview of tools and tasks in various biological and biomedical imaging modalities, such as microscopy, magnetic resonance imaging, x-ray computed tomography, ultrasound and others. Students will be exposed to the major underlying principles in modern imaging systems as well as state of the art methods for processing biomedical images such as deconvolution, registration, segmentation, pattern recognition, etc. The discussion of these topics will draw on approaches from many fields, including physics, statistics, signal processing, and machine learning. As part of the course, students will be expected to complete an independent project. Students will have the opportunity to visit laboratory to see real biomedical imaging devices in action. Prerequisites: 18-290 Signals and Systems or permission of the instructor, working knowledge of Matlab, and some image processing experience. Cross-listed courses: 18-496 Prerequisites: 18-396 and 42-202.

42-441 Cardiovascular Biomechanics  
Intermittent: 9 units  
This course covers the solid and fluid mechanics of the heart and vascular system as well as the mechanics of medical devices used to assist or replace cardiovascular function. Prerequisite: 42-341 Introduction to Biomechanics.

42-444 Medical Devices  
Fall: 9 units  
This course is an introduction to the engineering, clinical, legal and regulatory aspects of medical device performance and failure. Topics covered include a broad survey of the thousands of successful medical devices in clinical use, as well as historical case studies of devices that were withdrawn from the market. In-depth study of specific medical devices will include: cardiovascular medicine, orthopedics, and general medicine. We will study the principles of operation (with hands-on examples), design evolution, and modes of failure. Additional lectures will provide basic information concerning biomaterials used for implantable medical devices (metals, polymers, ceramics) and their biocompatibility, mechanisms of failure (wear, corrosion, fatigue, fretting, etc.). The level of technical content will require junior standing for MCS and CIT students, a degree in science or engineering for non-MCS or non-CIT graduate students, or permission of the instructor for all other students.

42-447 Rehabilitation Engineering  
Fall: 9 units  
Rehabilitation engineering involves the application of engineering principles to design, develop, adapt, and apply technology to problems confronted by individuals with disabilities. It differs from classical biomedical engineering by its focus on improving the quality of people’s lives, rather than improving medical treatment. The course surveys assistive technologies for various functional limitations - including mobility, hearing, vision, communication, and cognition - applied to activities associated with independent living, education, employment, and integration into the community. We consider human factors and many factors that make some innovative technologies successful and others commercial failures. Engineering innovation by itself - without considering other factors – means that some innovative technologies don’t become or remain available to aid people with disabilities.

42-509 Stem Cell Engineering  
Spring: 9 units  
Stem Cell Engineering This class will give an overview over milestones of stem cell research and will expose students to current topics at the frontiers of this field. It will introduce to the different types of stem cells as well as environmental factors and signals that are implicated in regulation of stem cell fate. The class will highlight techniques for engineering of stem cells and their micro-environment. It will evaluate use of stem cells for tissue engineering and therapies. Emphasis will be on discussion of current research areas and papers in this rapidly evolving field. Students will pick a class-related topic of interest, perform a thorough literature search, and present their findings as a written report as well as in paper reviews and a lecture during class. Lectures and discussion will be complemented by practical lab sessions, including: stem cell harvest and culture, neural stem cell transfection, differentiation assays and immunostaining, polymeric microcapsules as advanced culture systems, and stem cell integration in mouse brain tissue. The class is designed for graduate students with a strong interest in stem cell biology and the desire to actively contribute to discussions in class. Prerequisites: None. Co-requisites: None.
Course Descriptions

42-520 Tissue Engineering
Spring: 12 units
This course will train students in advanced cellular and tissue engineering methods that apply physical, mechanical and chemical manipulation of materials in order to direct cell and tissue function. Students will learn the techniques and equipment of bench research including cell culture, immunofluorescent imaging, soft lithography, variable stiffness substrates, application/measurement of forces and other methods. Students will interact in classroom lectures and lab skills by applying the scientific method to develop a unique project while working in a team environment, keeping a detailed lab notebook and meeting mandated milestones. Emphasis will be placed on developing the written and oral communication skills required of the professional scientist. The class will culminate with a poster presentation session based on class projects. Prereqs: Cell biology and Biomaterials, or permission of instructor.

42-530 Biological Transport and Drug Delivery
Spring: 9 units
Analysis of transport phenomena in life processes on the molecular, cellular, organ and organism levels and their application to the modeling and design of targeted or sustained release drug delivery technologies. Coupling of mass transfer and reaction processes will be a consistent theme as they are applied to rates of receptor-mediated solute uptake in cells, drug transport and biodistribution, and drug release from delivery vehicles. Design concepts underlying new advances in nanomedicine will be described. Pre-requisites: 06-262 Mathematical Methods of Chemical Engineering or 21-260 Differential Equations
Prerequisites: 06-262 or 21-260.

42-531 Computational Methods in Biomedical Engineering
Spring: 12 units
This goal of this course is to enable students with little or no programming background to solve simple computational problems in science and engineering. Emphasis will be placed on enabling students to use currently available numerical methods (rather than developing anew) to solve engineering problems. Upon completing the course, the successful student will be able to use basic knowledge regarding computer architecture, data types, binary arithmetic, and programming, to solve sample quantitative problems in engineering. Topics will include: solving linear systems of equations, model fitting using least squares techniques (linear and nonlinear), data interpolation, numerical integration and differentiation, solving differential equations, and data visualization. Specific example computations in each topic above will be drawn from problems in physics, chemistry, as well as signal and image processing, and biomedical engineering. Students will work independently in groups for a final project. Matlab will be used as the programming language/environment for this class, although different languages such as C, Java, and Python will be briefly discussed (time permitting). Pre-requisite or Co-requisite: calculus, multivariate calculus, linear algebra, and differential equations
Corequisites: 21-260, 21-122, 21-121.

42-540 Introduction to Biomedical Signal Processing
9 units
This course is geared towards graduate students who have not been exposed to signal processing before. The aim is to introduce the basic signal processing tools for analysis and mining of biomedical signals. The course will include an introduction to digital sequences (1D and multID), systems, and analysis tools (Fourier and wavelet). We will cover some basic tasks used in various biomedical processing applications. Students will team up in semester-long projects. Basic knowledge of Matlab is recommended but not required. Basic mathematics for engineers including basic linear algebra, or permission of the instructor, is required. This course is open to graduate students only.

42-550 Technological Innovation in Biomedical Engineering
Intermittent: 9 units
Developing innovative technologies in biomedical engineering requires understanding patents and intellectual property as well as understanding patient needs and market pull. This course will introduce students to technological innovation through discussion of case studies across biomedical engineering. Students will learn to read patents and analyze patent landscapes as well as discuss approaches to developing creative solutions that meet product and regulatory requirements. A team-based project will allow students to apply their skills in biomedical engineering and the tools in this course to proposing novel therapeutics, devices, or diagnostics that meet critical patient needs and have market potential.

42-570 Molecular and Micro-scale Polymeric Biomaterials in Medicine
Spring: 9 units
This course will cover aspects of polymeric biomaterials in medicine from molecular principles to device scale design and fabrication. Topics include the chemistry, characterization, and processing of synthetic polymeric materials; cell-biomaterials interactions including interfacial phenomena, tissue responses, and biodegradation mechanisms; aspects of polymeric micro-systems design and fabrication for applications in medical devices. Recent advances in these topics will also be discussed. Pre-requisite: None.

42-580 Bioinstrumentation
Intermittent: 12 units
This course aims to build the foundation of basic principles, applications and design of medical instrumentation. Topics covered include biosignals recording, transducers for biomedical application, action potentials EMG, EEG, ECG, amplifiers and signal processing, blood flow and pressure measurements, data acquisition and signal conditioning, spectral analysis of data, filtering, and safety aspects of electrical measurements. Ultimately, students will learn (1) how to apply basic circuit theory to perform measurement of biosignals, (2) be familiar and use common measurement devices, such as multimeter and oscilloscope, (3) be familiar with Op-amps circuits, (4) how to acquire and analyze a signal using time and frequency techniques, and (5) how to filter a signal to remove noise. Pre-requisites: junior standing in CIT, 33-107 (Physics II for Engineers), or permission of the instructor.

42-620 Engineering Molecular Cell Biology
Fall: 12 units
Cells are not only basic units of living organisms but also fascinating engineering systems that exhibit amazing functionality, adaptability, and complexity. Applying engineering perspectives and approaches to study molecular mechanisms of cellular processes plays a critical role in the development of contemporary biology. At the same time, understanding the principles that govern biological systems provides critical insights into the development of engineering systems, especially in the micro- and nanotechnology. The goal of this course is to provide basic molecular cell biology for engineering students with little or no background in cell biology, with particular emphasis on the application of quantitative and system perspectives to basic cellular processes. Course topics include the fundamentals of molecular biology, the structural and functional organization of the cell, the cytoskeleton and cell motility, the mechanics of cell division, and cell-cell interactions. Pre-requisites: 21-260 Differential Equations, or 06-262 Mathematical Methods of Chemical Engineering, or 18-202 Mathematical Foundations of Electrical Engineering. Advanced undergraduate or graduate student standing is required. Prior completion of 03-121 Modern Biology is suggested but not required. Proficiency in basic computation such as MATLAB programming is expected.

42-622 Bioprocess Design
Spring: 9 units
This course is designed to link concepts of cell culture, bioseparations, formulation and delivery together for the commercial production and use of biologically-based pharmaceuticals; products considered include proteins, nucleic acids, and fermentation-derived fine chemicals. Associated regulatory issues and bioprocess industry case studies are also included. The format of the course is a mixture of equal parts lecture, open discussion, and participant presentation. Course work consists of team-oriented problem sets of an open-ended nature and individual-oriented industry case studies. The goals of the course work are to build an integrated technical knowledge base of the manufacture of biologically based pharmaceuticals and U.S. biotechnology industry. Working knowledge of cell culture and modern biology, biochemistry and differential equations is assumed. Pre-requisite: 42-321 Cellular and Molecular Biotechnology or both 03-232 Biochemistry and 06-422 Chemical Reaction Engineering, or instructor permission.
Prerequisites: 03-232 or 06-422 or 42-321.

42-632 Neural Signal Processing
Fall: 12 units
The vast majority of behaviorally relevant information is transmitted through the brain by neurons as trains of action potentials. How can we understand the information being transmitted? This class will cover the basic engineering and statistical tools in common use for analyzing neural spike train data, with an emphasis on hands-on application. Topics may include neural spike train statistics (Poisson processes, interspike intervals, Fano factor analysis), estimation (MLE, MAP), signal detection theory (d-prime, ROC analysis, psychometric curve fitting), information theory, discrete classification, continuous decoding (PVA, OLE), and white-noise analysis.
42-640 Computational Bio-Modeling and Visualization
Spring: 12 units
Biomedical modeling and visualization play an important role in mathematical modeling and computer simulation of real/artificial life for improved medical diagnosis and treatment. This course integrates mechanical engineering, biomedical engineering, computer science, and mathematics together. Topics to be studied include medical imaging, image processing, geometric modeling, visualization, computational mechanics, and biomedical applications. The techniques are applied to examples of multi-scale biomodeling and simulations at the molecular, cellular, tissue, and organ level scales.

42-641 Bio Inspired Robotics
Fall: 12 units
This course investigates animal locomotion principles such as ground locomotion, flapping flight, swimming, and water surface locomotion and adapting those principles to bio-inspired robotic platforms. It uses the ‘Principles of Animal Locomotion’ book as the main course textbook while adding many recent updates and robotic content from research articles and news. Besides the basic biomechanics, locomotion dynamics, and mechanism design knowledge, it includes the current trends in literature, detailed case studies and discussions, and guest lecturer talks. Course final projects involve theoretical and hands-on topics on design, analysis, manufacturing, and control of bio-inspired robots with various locomotion capabilities. In addition to a final project presentation and report, the course requires a literature survey report and weekly or biweekly homework, and involves several quizzes. Pre-requisite: None.

42-642 Biological Fluid Mechanics
Spring: 12 units
Fluid dynamics and transport phenomena associated with biological and biomedical problems are studied through selected topics from cardiovascular fluid dynamics, swimming/flying in nature and biomimetic technologies. Course objectives are to prepare students to design and perform contemporary research in physiological, biological and biomedical fluid mechanics, and to understand emerging biomimetic engineering methods, emphasizing quantitative understanding and fundamental engineering concepts. Computational and experimental techniques (CFD, flow visualization, PIV, LDV, POD, confocal microscopy) will be studied with hands-on research projects. Principles of interdisciplinary (biologist/clinician/engineer) collaboration are emphasized. The course is intended for advanced undergraduate and entering graduate students. Familiarity with elementary fluid mechanics and introductory Matlab programming is expected. Students who have not previously taken a fluid dynamics class should consult with the instructor.

42-643 Microfluidics Intermittent
Intermittent: 12 units
This course offers an introduction to the emerging field of microfluidics with an emphasis on chemical and life sciences applications. During this course students will examine the fluid dynamical phenomena underlying key components of “lab on a chip” devices. Students will have the opportunity to learn practical aspects of microfluidic device operation through hands-on laboratory experience, computer simulations of microscale flows, and reviews of recent literature in the field. Throughout the course, students will consider ways of optimizing device performance based on knowledge of the fundamental fluid mechanics. Students will explore selected topics in more detail through a semester project. Major course topics include pressure-driven and electrokinetically-driven flows in microchannels, surface effects, micro-fabrication methods, micro/nanoparticles for biotechnology, biochemical reactions and assays, mixing and separation, two-phase flows, and integration and design of microfluidic chips. Pre-requisites: 24-231 or 06-261 or 12-355 or instructor permission.

42-645 Cellular Biomechanics
Spring: 9 units
This course discusses how mechanical quantities and processes such as force, motion, and deformation influence cell behavior and function, with a focus on the connection between mechanics and biochemistry. Specific topics include: (1) the role of stresses in the cytoskeleton dynamics as related to cell growth, spreading, mobility, and adhesion; (2) the generation of force and motion by motor molecules; (3) stretch-activation ion channels; (4) protein and DNA deformation; (5) mechanoochemical coupling in signal transduction. If time permits, we will also cover protein trafficking and secretion and the effects of mechanical forces on gene expression. Emphasis is placed both on the biology of the system and on the fundamental physics, chemistry and mechanics which describe the molecular level phenomena within context. In addition to studying the structure, mechanics and energetics of biological systems at the nanoscale, we will also study and conceptually design biomimetic molecules and structures. Fundamentals of DNA, globular and structured proteins, lipids and assemblies thereof will be covered.

42-646 Molecular Biomechanics
Spring: 9 units
This class is designed to present concepts of molecular biology, cellular biology and biophysics at the molecular level together with applications. Emphasis will be placed both on the biology of the system and on the fundamental physics, chemistry and mechanics which describe the molecular level phenomena within context. In addition to studying the structure, mechanics and energetics of biological systems at the nanoscale, we will also study and conceptually design biomimetic molecules and structures. Fundamentals of DNA, globular and structured proteins, lipids and assemblies thereof will be covered.

42-647 Introduction to Continuum Biomechanics
Spring: 12 units
This course provides a general survey of the application of continuum mechanics (fluid and solid mechanics) to biomechanics. The course as whole encourages class participation and discussion in a seminar-type fashion. The course begins with a historical review of the subject followed by a review of vector and tensor analysis, before discussing various measures of deformation and stress formulations. The development and understanding of appropriate constitutive models for particular problems are at the core of this course. Both analytical and to some extent experimental results are presented through readings from reports in recent journals and the relevance of these results to the solution of unsolved problems is highlighted. The main objective of this course is to provide the basic ideas of continuum mechanics for engineering and science students with little or no background in Biomechanics, with particular emphasis on the application of quantitative and system perspectives to fluid and solid mechanics problems. In addition to looking at various examples with biomechanics applications, the last few weeks of the course are dedicated to discussing individually-crafted research projects for the students. Pre-requisite or Co-requisite: 21-260 Differential Equations, 24-231 Fluid Mechanics, 24-262 Mechanics of Deformable Solids, or permission of instructor.

42-660 Surgery for Engineers
Fall and Spring: 9 units
Students will interact with clinical practitioners and investigate the technological challenges that face these practitioners. All students must sign up for one of the three accompanying practicums: Clinical Neuroscience, Clinical Cardiovascular, or Clinical Orthopedic. Students will complete a final report on the practicum that will describe an important clinical problem that can be solved with a new technology or a significant optimization of an existing technology. Prerequisite: 42-202 Physiology. Prerequisite: 42-202.

42-699 Special Topics
Fall and Spring: 9 units
42-699-A: Technical Innovation for Biomedical Engineering Developing innovative technologies in biomedical engineering requires understanding patents and intellectual property as well as understanding patient needs and market pull. This course will introduce students to technological innovation through discussion of case studies across biomedical engineering. Students will learn to read patents and analyze patent landscapes as well as discuss approaches to developing creative solutions that meet product and regulatory requirements. 42-699-B: Neural Data Analysis The vast majority of behaviorally relevant information is transmitted through the brain by neurons as trains of actions potentials. How can we understand the information being transmitted? This class will cover the basic engineering and statistical tools in common use for analyzing neural spike train data, with an emphasis on hands-on application. Topics may include neural spike train statistics (Poisson processes, interspike intervals, Fano factor analysis), estimation (MLE, MAP), signal detection theory (d-prime, ROC analysis, psychometric curve fitting), information theory, discrete classification, continuous decoding (PVA, OLE), and white-noise analysis. 42-699-C: Basic Statistics for Biomedical Research This is a lecture/seminar course designed to cover medical experimental design, types of statistical error and the mechanics of commonly used statistical methods. Emphasis will be placed on use of appropriate statistical tools as opposed to the mathematical underpinnings of the statistical tests themselves. Students will be expected to solve statistical problems derived from clinical practice as well as the medical literature. Web-based resources as well as a statistical software package will be provided.
42-735 Medical Image Analysis
Spring: 12 units
Students will gain theoretical and practical skills in medical image analysis, including skills relevant to general image analysis. The fundamentals of computational medical image analysis will be explored, leading to current research in applying geometry and statistics to segmentation, registration, visualization, and image understanding. Student will develop practical experience through projects using the new v4 of the National Library of Medicine Insight Toolkit (ITK), a popular open-source software library developed by a consortium of institutions including Carnegie Mellon University and the University of Pittsburgh. In addition to image analysis, the course will include interaction with clinicians at UPMC. NEW THIS YEAR: ITKv4 includes a new simplified interface and many new features, several of which will be explored in the class. Extensive expertise with C++ and templates is no longer necessary (but still helpful). *** Some or all of the class lectures may also be videoed for public distribution. website: http://www.cs.cmu.edu/~galeotti/methods/ course/ Prerequisites: Knowledge of vector calculus, basic probability, and C++ or python (most lectures will use C++). Required textbook, "Machine Vision", ISBN: 0521116981X; Optional textbook, "Insight to Images", ISBN: 97801568812175.

Business Administration Courses

70-100 Global Business
Fall: 9 units
This course examines the fundamental issues in the development of new markets for products and services globally. In addition, it provides a foundation for understanding the functional areas of business and how they contribute to management of a firm. Students use this foundation knowledge to analyze cases and complete projects in order to gain an understanding of some of the key issues affecting a wide range of the most important global industries. First year students can also gain a better understanding of the vast array of career possibilities available to those who study business. This course is restricted to first-year business majors and students may not receive credit for both 70-100 and 70-101.

70-101 Introduction to Business Management
Fall and Spring: 9 units
This course examines the fundamental issues in the development of new markets for products and services globally. In addition, it provides a foundation for understanding the functional areas of business and how they contribute to management of a firm. Students use this foundation knowledge to analyze cases and complete projects in order to gain an understanding of some of the key issues affecting a wide range of the most important global industries. First year students can also gain a better understanding of the vast array of career possibilities available to those who study business. Students may not receive credit for both 70-100 and 70-101.

70-122 Introduction to Accounting
All Semesters: 9 units
This course provides the knowledge and skills necessary for the student to understand financial statements and financial records and make use of the information for management and investment decisions. Topics include an overview of financial statements and business decisions; the balance sheet, the income statement, and the cash flow statement; sales revenue, receivables, and cash; cost of goods sold and inventory; long-lived assets and depreciation, and amortization; current and long-term liabilities; owners' equity; investments in other corporations; an introduction to financial statement analysis and international issues dealing with financial statements.

70-160 Graphic Media Management
Fall: 9 units
This course provides a foundation for the study of graphic communications management by investigating the processes and materials used in the graphic arts. The subjects examined include typography, papermaking, ink technology, electronic imaging, process control and color separation.

70-194 Publishing Management in the Information Age
Spring: 9 units
As the digital era transforms the publishing industry, this course addresses how best to manage the opportunities brought about by profound technological changes. The course focuses on the management of intellectual property, the publishing process, career opportunities and the impacts of new technologies. Lectures, guest speakers and student business simulations integrate learning.

70-201 Professional and Service Projects
All Semesters: 9 units
Professional service is important in career development because it creates opportunities to use skills and knowledge, develop leadership abilities, develop professional networks, and to learn the importance of community involvement and social values in business practice. Students complete a variety of activities with these objectives over a period of up to four-(4) semesters to satisfy this course requirement.

70-207 Probability and Statistics for Business Applications
Fall: 9 units
Elementary ideas in probability, statistics and data analysis presented in the context of their importance to modern business management. Prerequisites: 21-120 or 21-121.

70-208 Regression Analysis
Spring: 9 units
This class focuses on the statistical analysis of the relationship between two or more random variables. In particular, we examine the estimation of the conditional mean of the dependent variable as a function of independent variables using linear regression. We draw on statistical theory to determine the precision of our estimates and to conduct inference about the population, and we examine a number of applications to business, finance and economics throughout the course.

Prerequisites: (21-212 or 21-116 or 21-112 or 21-120) and (36-201 or 70-207 or 36-310 or 36-220 or 36-247) and (73-100 or 73-110).

70-311 Organizational Behavior
Fall and Spring: 9 units
This course examines the factors which influence individual, group and firm behavior in the context of the workplace. Topics covered include perception, group behavior, decision making, motivation, leadership and organizational design and change.

Prerequisites: 76-100 or 76-101 or 76-214 or 76-236 or 76-245 or 76-327 or 76-331 or 76-347 or 82-085.

70-321 Negotiation and Conflict Resolution
9 units
This course will complement the technical and diagnostic skills you have learned in other courses at Tepper. A basic premise of the course is that, while you will need analytical skills to discover optimal solutions to problems, you will also need a broad array of negotiation skills to implement these solutions and make sure that they are truly effective. Your long-term effectiveness - both in your professional and personal life - is likely to depend on your negotiating abilities. This course will give you the opportunity to develop these skills experientially and to understand the analytical frameworks that underlie negotiations.

Prerequisites: 76-100 or 76-101 or 82-085.

70-332 Business, Society and Ethics
Fall and Spring: 9 units
The course draws upon actual cases to explore fundamental questions faced by businesses operating in the United States and elsewhere in the world. What justifies governmental regulation of your business? What are the rights of employers and employees? How does the law protect consumers? What laws protect the environment? How do you choose the best legal form for your business? What are the lines of power within a corporation? What protections are available to shareholders? How do the antitrust laws protect competition? What responsibilities does a business have to the community in which it operates? What is the ethical foundation on which business ought to be conducted? The course puts businesses in their legal and ethical context.

Prerequisites: 76-100 or 76-101 or 82-085.

70-339 Information Technology for Finance
6 units
The financial services industry is a leader in the use of information technology. Firms in banking, securities, investments, insurance and financial marketplaces are among the most information intensive and innovative users of technology. The course will examine the role and potential of technology in this industry. The course begins with a description of the financial markets, specifically, equity, foreign exchange, and derivatives, and the systems that enable them. It considers exchanges, ECNs, ATS’s Order Management Systems, Straight through Processing, Fix Protocol, and post trading clearance and settlement. It covers the design, evaluation and execution of popular trading strategies that are used by professionals in the various markets. There is increasing interest, in particular, on systematic trading strategies and execution systems because of their scalability and transparency. The course covers both Algorithmic and High Frequency Trading and analyzes issues regarding latency, scalability, and reliability.

Prerequisites: 70-391 and 70-451.
70-340 Business Communications
Fall and Spring: 9 units
Business Communications develops and sharpens your written, oral, and interpersonal communication, introducing you to common forms of professional writing and speaking in specific business situations. The course explores crucial rhetorical issues that impact your ability to communicate and achieve your objectives as a business leader.
Prerequisites: 76-100 or 76-101 or 76-104 or 82-085.

70-341 Organizational Communication
Fall: 9 units
Much of the work in groups and organizations consists of communication. You communicate to get information that will be the basis of decisions, to provide a vision for the people who work for and with you, to coordinate activity, and to sell yourself and your work. The goal of this course is to identify sources of communication problems within an organization and ways to overcome them. To do this requires that we know how communication normally works, what parts are difficult, and how to fix it when it goes wrong. The focus of this course is on providing you with a broad understanding of the way communication operates within dyads, work groups, and organizations. This course is not a practicum in public speaking or writing, although you will get some experience writing, speaking and managing impressions. Rather the intent is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from both the research and the managerial literatures. Among the topics considered are organizational communication, persuasion and conformity, self presentation and person perception, social networks. Cases and group projects give you an opportunity to apply what you've learned.
Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.

70-342 Managing Across Cultures
Spring: 9 units
This course is designed for students who expect to do business in other countries or work with people from other cultures. It provides an intellectual framework for understanding other cultures (and eventually one's own), as well as detailed studies of particular countries. It discusses how culture defines organizations, contracts, personal relationships, attitudes toward authority, time and space, ethics, wealth, and subcultures, and how these affect business. Student teams study a culture of their choice and make presentations, based on interviews and literature research.
Prerequisites: 76-100 or 76-101 or 82-085.

70-345 Business Presentations
Fall and Spring: 9 units
In this course, students prepare, present, discuss, and critique the different oral presentations currently practiced in business. Topics include developing verbal and physical presence; planning presentations based on audience needs and expectations; projecting personal credibility, professionalism, and appropriate emotional responses; and using various multimedia technology. Assignments and cases will cover informative and persuasive presentations, which will vary from term to term and may include talks such as formal public introductions; explanations of policy and/or procedures; employee training sessions; state-of-the-company addresses; sales presentations; team-driven strategic plans; public interviews with a hostile press; and talks on other more free-ranging topics.
Prerequisites: 70-340 or 73-270.

70-350 Business Acting
This course provides a uniquely broadening educational experience for business students through an exploration & understanding of the process of Acting & the unique performer/audience relationship. Using techniques of Acting, the course will concern itself with: a new self-awareness & greater confidence in public communication; the expansion & diversification of one’s range of personal expression; methods to more effectively shape a public performance & of empowering the student to put his/her best Self forward when in contact with an audience; & a re-investment in passion.

70-356 Business Law
Fall and Spring: 9 units
The external political, social and legal environment of the firm and its managers. Legal and regulatory matters, United States and multinational, will be considered, including restrictive trade practices laws and regulations, acquisitions and mergers, licensing, franchising, officers’ and directors’ responsibilities and liabilities, manufacturers’ responsibilities and liabilities, securities regulation, environmental protection, intellectual property, labor unions, trade associations, employee rights and duties, the attorney-client relationship; values in a business society; social implications of business policies, and corporate social responsibility. The effects of laws upon day-to-day business administration. Contracts, sales, commercial paper; the Uniform Commercial Code, credit transactions, bankruptcy, insurance, agency, partnership, incorporation and corporate governance.
Prerequisites: 76-100 or 76-101 or 82-085.

70-365 International Trade and International Law
Fall: 9 units
The course discusses the international legal system and laws that affect international trade. It covers the Foreign Corrupt Practices Act, treaties and conventions, shipping and customs, appointment of foreign sales agents, resolution of trade disputes, international mergers and joint ventures, international competition law, UN sales convention, international trade organizations (IMF, WTO, World Bank, etc.), risk insurance, cultural factors, international E-Commerce and intellectual property.
Prerequisites: 73-100 or 73-110.

70-366 Intellectual Property and E-Commerce
Spring: 6 units
This course covers the basics of doing business on the internet with emphasis on E-Commerce issues such as intellectual property, cyber squatting and commercial transactions.
Prerequisite: 76-101.

70-371 Production/Operations Management
Fall and Spring: 9 units
This course is an introduction to production and operations management that covers both manufacturing and services. It deals with strategic issues (design of flexible supply), planning issues (capacity management), and operational issues (inventory management and information). The linkage between strategy and tactics will be emphasized. The students will learn concepts and tools that will help them to manage from the “boardroom” to the “toolroom.”
Prerequisites: (21-257 or 21-292) and (70-207 or 36-202 or 36-310 or 36-220 or 36-247).

70-374 Forecasting and Data Mining
Fall: 6 units
Students will use state-of-the-art software on large data sets to illustrate key techniques for finding patterns in data and using them to make better, more effective business decisions.
Prerequisite: 70-208.

70-376 Energy Systems
Intermittent: 9 units
This course will provide students with an understanding of the systems and markets that provide energy to businesses and consumers. Students will be introduced to the sources and uses of energy, and how they have evolved and the possible paths over which they may evolve in the next decades. The course places an emphasis on electric energy, the single largest energy source in many industrial economies, but also covers natural gas, oil, and selected other primary energy sources. Students will learn the energy flows in the USA and the world, as well as the business-relevant characteristics of the engineered systems that provide the energy in various forms. Both traditional and emerging energy sources will be discussed, and students will understand the difference between an energy carrier and an energy source. We will also discuss some of the issues that arise without proper management of the physical risks of energy systems. Students will learn some of the history of electric power regulation and the inconsistent subsidy structures that have provided opportunities and challenges for energy companies and investors, including discussion of how emissions restrictions affect fuel, engineering investment, and project finance choices. The history of electric power markets will be discussed, with an eye to examining the opportunities that market changes create for business. Prerequisites include two semesters of statistics and either Production/Operations (70-371) or Operations Research (21-292) or permission of the instructor.
70-381 Marketing I
Fall and Spring: 9 units
An introduction to the nature and fundamentals of the marketing activity. Topics include an analysis of the economic factors influencing buyer behavior, marketing research, market segmentation, development of marketing programs (new product, price, advertising and distribution decisions), and international marketing.
Prerequisites: 70-100 or 76-101 or 76-214 or 76-236 or 76-245 or 76-327 or 76-331 or 76-347 or 82-085.

70-385 Consumer Behavior
All Semesters: 9 units
Marketing, in particular, begins and ends with the consumer – from determining consumer needs to ensuring customer satisfaction. In this course, we will explore the most recent scientific research in marketing, psychology, and behavioral economics on judgment and decision-making. We will develop your ability to understand and influence what people want, how people decide what and when to buy, and whether people will be satisfied or dissatisfied with their decisions. These psychological insights are particularly useful for marketing strategy, brand positioning, and marketing communication decisions, but also yield insight into common biases in judgment and decision making, beyond marketing, to which you would otherwise fall prey. Why people are willing to drive across town to save $5 on a tank of gasoline, for example, when they would not drive a minute to save $5 on a refrigerator. We will discuss some of these applications in class. In addition, we will examine the methodology of market research (specific to consumer behavior) to build the tools you will need to interpret and base decisions on it.
Prerequisite: 70-381.

70-391 Finance
Fall and Spring: 9 units
Students are introduced to a quantitative approach to evaluating the decisions of firms and individuals. Stress is placed on logic and analytical approaches to problems such as portfolio choice or capital structure. Students learn both to draw inferences from the prices observed in markets and also to apply the normative standards of present value rules, diversification, and asset pricing theories. The role of reputation and ethics in the development of trustworthy markets is also studied.
Prerequisites: (70-208 and 21-257 and 70-122) or (70-208 and 21-292 and 70-122) or (21-370).

70-395 Funding Entrepreneurial Ventures
All Semesters: 9 units
So you want to do a startup and you know that you need funding. There are multiple ways to fund a new venture: bootstrapping, economic development, angels, venture capitalists. The question is what are these funders looking for in an early stage investment? What is important to them? How do they decide which companies to invest in and with which? This class looks at funding from the funder’s point of view and provides the student with a framework of the investment process: investment criteria, sourcing, due diligence, deal structure, valuation, post investment involvement. Real companies seeking funding are used for the final project in which students will be expected, as investment teams, to make investment decisions and convince their fellow investors (the class) to join them (or not). This is a highly interactive and project class. There will be multiple guest speakers. Prerequisites: Students are highly encouraged to take any of the introductory entrepreneurship classes offered in various schools and departments. While no financial background is required, this class will not cover the basics of entrepreneurship from the entrepreneur’s perspective, but will be looking from the investor point of view.

70-397 Introduction to Entrepreneurial Finance
Fall: 6 units
Venture capital and private equity play a crucial role in the financing and development of innovative entrepreneurial firms. This course covers the financial tools and methods used by entrepreneurs and investors when selecting and valuing entrepreneurial investments. Such analysis presents unique challenges unique to high-growth firms with little or no revenues. Through extensive case-study, group projects, and outside speakers, the students will study investment and business design issues from the perspective of both the investor (angel, venture capital or private equity) and the entrepreneur. Major topics include a detailed look at the financial market (angels, venture capital and private equity), an analysis of assets and liabilities in an entrepreneurial firm, structuring the ownership of start-ups, and the multiple valuation methods available for investment assessment. Prerequisite: Course #70-415, “Introduction to Entrepreneurship” (to enroll, contact uba@andrew.cmu.edu)
Prerequisite: 70-391.

70-398 International Finance
Fall: 9 units
International Finance covers the major international financial markets and how firms use them to solve business problems. The course begins with an institutional and analytical description of the markets for foreign exchange, eurocurrency deposits, currency swaps and currency options. It goes on to examine how financial institutions and non-financial firms use these markets for asset management and foreign currency risk management. Applications and cases change from year-to-year to reflect current events. Recent examples are the disruption in the LIBOR markets associated with the 2007-2009 financial crisis, the risk-return characteristics of the foreign-currency carry trade and the growing importance of China and other trade-surplus countries in understanding global capital flows and sovereign wealth funds. The risk-management component of the course emphasizes the strengths and weakness of the Value-at-Risk methodology in the context of exchange rate changes and the 2007-2009 financial crisis.
Prerequisites: 70-391 and 73-200.

70-401 Management Game
Spring: 12 units
This course is designed to integrate the managerial concepts and techniques studied earlier in the curriculum and to focus on elements of organizational structure and behavior. Student teams assume the role of top management of firms competing in an international economy simulated by the Carnegie Mellon University Management Game. Each team is responsible to a Board of Directors comprised of alumni of the MBA program and business masters students. Emphasis is placed on the development and implementation of sound organizational decision structures as well as the formulation of effective competitive strategies.
Prerequisites: (70-121 and 70-371 and 70-381 and 70-391) or (70-122 and 70-371 and 70-381 and 70-391).

70-414 Technology Based Entrepreneurship for CIT
Fall: 9 units
Technology-Based Entrepreneurship is an introductory course in entrepreneurship. The course primarily targets non-business students and assumes no background in business. Students majoring in science, computer science, engineering, the humanities or the arts are exposed to fundamental concepts and issues around innovation and entrepreneurship. The course provides a foundation for starting a new venture and innovating new technologies and products within existing organizations. Topics covered will include: identifying a business opportunity, building a team, finance, equity investment, managing risk, market understanding, and competitive advantage. Emphasis will be on team projects, including developing an investor pitch for an original idea.

70-415 Introduction to Entrepreneurship
Fall: 9 units
This course is designed primarily to provide an overview of entrepreneurship, develop an entrepreneurial frame of mind and learn the rudiments of how to differentiate an idea from an opportunity. Students come up with a business idea, explore its potential for a viable business. They learn to do market research and experience first-hand the rewards and difficulties in dealing with people in the real world. They will meet entrepreneurs and business professionals as part of the course and learn how to make effective presentations — both written and oral. Other important aspects of the course include self-assessment to determine one’s strengths and weaknesses, understanding the “magic” of leadership and gaining an entrepreneurial perspective on life.

70-416 New Venture Creation
Spring: 9 units
This course exposes students to the nuances of financing new ventures, getting them started legally and marketing their products or services. Students pull together all the ideas and information from different functional aspects of their projects into coherent and persuasive mini-business plans that serve as roadmaps for building their businesses; and useful instruments to find sufficient financing for the new ventures, so that they can convince business leaders to fund the outside world that these opportunities are viable, with substantial potential for success. Prerequisite: 70-414 or 70-415 or 70-420 or 70-422 or 15-390.
Prerequisites: 15-390 or 70-414 or 70-415 or 70-420 or 70-421.

70-417 Topics in Entrepreneurship
Fall and Spring: 9 units
An independent study course in which students work on a one-to-one basis with the instructor to study in depth particular topics in which they are interested. Topics can include family business, entrepreneurship or development of their mini-business plan into a full-blown business plan.
70-418 Financing Entrepreneurship Ventures
Spring: 9 units
This course addresses the financial issues facing entrepreneurs. Various sources of financing are covered including bootstrapping, angels, venture capitalists and others. Guest entrepreneurs are invited to class to discuss how they got sufficient funding at the various stages of building their companies. In addition, the venture capital industry is reviewed and issues involved in arriving at company valuations are discussed.

70-419 Entrepreneurship Practicum: Apprentice
All Semesters: 9 units
Topics covered include: identifying a business opportunity, building a team, finance, managing risk, and understanding your competitive advantage. We put a “real world” perspective on entrepreneurship, innovation and leadership. The output of the course is a mini-business plan or venture opportunity screening document that can be developed into a business plan in a subsequent course entitled New Venture Creation or through independent study. No prerequisites.

70-420 Entrepreneurship for Scientists
9 units
Entrepreneurship for Scientists is an introductory course in entrepreneurship. The course primarily targets non-business students and assumes no background in business. Students majoring in science, computer science, engineering, the humanities or the arts are exposed to fundamental concepts and issues around innovation and entrepreneurship. The course provides a foundation for starting a new venture and innovating new technologies and products within existing organizations. Topics covered will include: identifying a business opportunity, building a team, finance, equity investment, managing risk, market understanding, and competitive advantage. Emphasis will be on team projects, including developing an investor pitch for an original idea.

70-421 Entrepreneurship for Computer Scientists
All Semesters: 9 units
This course is primarily for non-business school students; it includes most of 70-415, assumes no background courses in business and involves additional sessions for core business concepts. Students with majors in science, technology, engineering or computer science are exposed to fundamental concepts and issues in innovation, business and entrepreneurship. Students can expect to gain a basic understanding of functional areas such as finance, funding, marketing, sales and management. Student Status: Sophomore.

70-422 Managerial Accounting
Intermittent: 9 units
The purpose of this course is to provide an introduction to the measurement and allocation of costs. Emphasis will be given to the use of cost information in decision making in organizations. The course will cover standard topics in cost accounting, such as cost behavior and relevant costs, and will connect these to broader issues in microeconomics, decision theory, corporate finance, and operations management. Classes will be a mixture of conventional lectures and laboratory experiments. Prerequisites: (70-122) and (36-202 or 70-207).

70-423 Entrepreneurship for Scientists and Engineers
9 units

70-424 Corporate Financial Reporting
Spring: 9 units
This course is designed to strengthen your ability to correctly interpret financial statements and their accompanying disclosures. The course is aimed at anyone whose career might involve working with accounting data, and should be especially useful for those interested in consulting and financial analysis. Throughout the semester we will discuss the key disclosure rules in the United States, the communication methods available to managers, managers’ incentives and ability to exert discretion over reported earnings, and the interplay between a company’s corporate strategy and its financial reporting policies and practices. The course revolves around a number of topics of recent interest to the business community including the quality of earnings, mergers and acquisitions, purchased R&D, post employment benefits, executive compensation, and intangible assets. Prerequisite: 70-122.

70-428 Financial Statement Analysis
9 units
This course is about fundamental analysis using financial statements. We develop and apply technologies for understanding and identifying firm activities that generate shareholder value and for developing valuation benchmarks. The ultimate goal of such analysis is to aid the security valuation and risk analysis exercises. This course is intended to help students establish a good foundation and introduce students the basics of equity and debt analysis techniques. Prerequisite: 70-122.

70-430 International Management
Spring: 9 units
This course uses the case method to examine the strategic and operational issues in management practice and decision-making that are important in operating a business that spans national borders. Topics include political and economic risk assessment, technology transfer, cultural analysis, negotiation, social responsibility, organization structure, supply chain management and trends in foreign direct investment and their impact on developing strategies for entering and becoming successful in international markets.

70-437 Organizational Learning and Knowledge Management
9 units
Managing knowledge effectively is key to the performance and competitiveness of both entrepreneurial and established organizations. The course examines why some organizations are better than others at learning from experience and developing new knowledge. The course focuses on how organizations innovate or create new knowledge, how they retain knowledge, and how they transfer knowledge. Strategic implications of new results on organizational learning and knowledge management are also developed. Students will acquire a greater appreciation of the dynamics of organizations and factors contributing to their performance. A mix of lectures, guest presentations, cases and exercises are used to increase your ability to create, retain and transfer knowledge effectively in organizations. Prerequisites: 36-202 or 36-208 or 36-217 or 36-220 or 36-225 or 36-226 or 70-208.

70-438 Commercialization and Innovation
9 units
Commercialization and Innovation is targeted at entrepreneurs and innovators who are interested in introducing innovations into the marketplace through organizations whether they are start-up, emerging, or mature companies. In this class you will learn how to evaluate, develop and describe: current or targeted industries in terms of the competitive landscape (signals for opportunities for change, competitive landscape, and strategic choices); market opportunities for customer/user needs (jobs to be done, user context and value propositions); business models appropriate for these markets, potential solutions identified to address customer/user needs (minimum viable product concept), and identification for high-need market segments and entry points (MEP), and strategies for growth. The class covers concepts and tools for analysis such as disruptive and sustained innovation, open innovation, outcome driven innovation (and, an agile approach). Team based projects are carried out by student teams starting who start with understanding opportunities in emerging industry contexts (e.g. cloud computing, 3D manufacturing, the industrial Internet, healthcare IT, biotechnology, etc). Project areas are selected based on student interest, and progress from industry analysis to understanding need, and then with development of proposed solutions for significant needs identified by the teams. Students will be expected to present their work during the course both verbally and in written form. Prerequisites: (73-150 or 73-230) and (70-414 or 70-415 or 70-420 or 70-421).

70-440 Corporate Strategy
Fall: 9 units
This course is designed to provide the student with a general management perspective and an understanding of the total business enterprise. It builds upon previous course work in functional areas and provides insights and analytical tools which a general manager should have in order to plan and implement successful business strategy. The student will analyze complex business problems and formulate realistic strategic solutions. Emphasis is placed on the practical application of business theory by the student in his/her business career. Prerequisites: 70-122 and 70-371 and 70-381 and 70-391.
70-449 Social, Economic and Information Network
Spring: 6 units
This is a new course exploring the networked nature of social, market and information interactions and building simple models for them that explain their qualitative behavior. Topics include how opinions, trends and fads grow and spread, and the politics, economics and technology of on-line networks. Methods discussed will include similarity and centrality measures in social networks, auctions and matching markets in economic networks, the structure of the web, models of internet search and sponsored search auctions in information networks. Models of network dynamics will also be introduced, such as the formation of cascades, the diffusion of innovation, network effects, power laws and rich-get-richer phenomena, the small world phenomenon and epidemic models.
Prerequisite: 70-451.

70-451 Management Information Systems
Fall: 9 units
The objectives of this course are to provide students with basic knowledge of the technology used in computer-based information systems and to enable them to acquire the skills for analyzing how to manage this technology in business. There is a strong emphasis on how to become both an intelligent user of information systems and also an effective participant in the design process of these systems. Credit will not be allowed for both 70-451 and the Information Systems major course 67-272.
Prerequisites: 15-110 or 15-102 or 15-105 or 15-110 or 15-121 or 15-112 or 15-120 or 15-125 or 15-127.

70-453 Systems Analysis and Design
Spring: 9 units
This course is designed to provide students with a basic understanding of how to develop and implement computer-based management information systems. Students will be introduced to a variety of system development concepts and techniques. These can include traditional approaches such as top-down or structured analysis, problem definition, feasibility analysis, enterprise analysis and data flow diagrams, as well as interactive and iterative development approaches such as prototyping and object-oriented concepts and techniques. The course also explores topics related to successful implementation of systems such as testing strategies, project management, user-oriented design and software maintenance. Students will work in teams to analyze, design and build a small information system.
Prerequisite: 70-451.

70-455 Information Resource Management
Spring: 9 units
The objective of this course is to explore information resources management issues from a managerial perspective. In this course students learn how information resources can influence and define corporate strategy, how to discover opportunities to gain competitive advantages with information resources and how managers control the development and use of such information resources (covering topics such as end-user computing expert systems and privacy). Students also learn how to model and analyze corporate information needs, how database management systems serve to support those needs and how managers address significant issues concerning that support.
Prerequisite: 70-451.

70-456 Telecommunication and Network Management
Fall: 9 units
This course introduces students to telecommunication and computer network technologies. We discuss computer telecommunications, local area networks and wide area networks. Topics include the ISO reference model; network architecture; data communications; local area networks; and ISDN. Students will develop a project to demonstrate the impact of telecommunication technology in business.
Prerequisite: 70-451.

70-460 Mathematical Models for Consulting
Fall: 9 units
This course covers a wide variety of mathematical models and techniques used by consultants and which lie at the heart of much decision-support software. Building on the basic methods from the operations research courses, we will discuss the benefits and limitations of different modeling and solving techniques, e.g., linear, integer and stochastic models, to strategic, tactical and operational level decision making, and examine the most successful recent work from real life applications in detail. While doing so, we will follow primarily a practical spreadsheet based approach to provide hands-on experience with software such as Excel Solver.
Prerequisites: 21-257 or 21-259 or permission of the instructor.
Prerequisites: 21-257 or 21-292.

70-462 Stochastic Modeling and Simulations
All Semesters: 9 units
This hands-on course on computer simulation of business, service, and manufacturing systems (that are subject to uncertainty or risk) takes the perspective of the consultant whose job is to analyze stochastic decision problems by building a simulation model and using it to understand the behavior of the system and explore the effects of alternative decisions. Two modeling methodologies will be presented: 1) Models, both static and dynamic, that can be implemented as mathematical expressions in a spreadsheet; and 2) discrete-event models that utilize the event scheduling formalism. @Risk, from Palisade Corporation, is the tool that will be used to demonstrate how to build and execute spreadsheet simulation and Arena, from Rockwell Software, is the tool that will be used to demonstrate how to build discrete-event simulation models for service and manufacturing applications. Upon completion of the course students will be able to carry out the entire process of designing the model, implementing it in the appropriate software, executing the simulation, collecting and analyzing output data, and using the results of the analysis to evaluate alternative decisions.
Prerequisites: 36-202 or 36-225 or 70-207.

70-465 Technology Strategy
Spring: 9 units
This course is about business strategy for technology-intensive industries. Examples of such industries are computer hardware and software, media and entertainment, telecommunications and e-commerce. We will explore the unique economic circumstances facing firms in these industries and identify strategies that enable firms to succeed given these circumstances. You will learn to analyze pricing strategies including versioning and bundling; product standardization decisions; managing product complements; exploiting network effects; managing platform competition. This course will help you understand the unique economic characteristics seen in today’s technology-intensive markets and how they impact the strategic interactions among firms and consumers. We will study, for example: Why firms in the IT industry give away their best products for free. Why makers of video gaming consoles subsidize end users (but tax game developers) while computer operating system makers subsidize software developers (but overcharge end users). Why Sony won the Blu-Ray format war against HD-DVD which was sponsored by a whole array of companies. In order to understand how firms strategically interact with consumers in technology-intensive industries this course will use a combination of simple but rigorous analytical models, emerging theories, and formal case studies.
Prerequisite: 70-451.

70-471 Logistics and Supply Chain Management
Spring: 9 units
During the course we will discuss the basic issues of Supply Chain Management like inventory management, risk pooling, network planning and supply contracts as well as we some of the more concurrent issues. In the face of a globalizing economy we will discuss procurement and outsourcing strategies, global logistics and risk management. As supply chains generally cross firm boundaries we will look at supply chain integration, and alliances from a supply chain perspective. Also, as more and more information can be gathered about customers you will learn how to judge the value of this information and whether or not one should adopt a customer specific pricing model. The above issues will be covered at a general strategic level but whenever possible you will also learn how to quantitatively make trade-offs between alternatives.
Prerequisite: 70-371.

70-474 Quality Principles and Techniques
Spring: 9 units
The goal in this course is twofold: (i) to develop a high-level understanding of the ideas and philosophies concerning quality in business processes; and (ii) to develop expertise with the tools used to evaluate and improve quality. The goal of the course is not to indoctrinate students into any single quality assurance framework, but rather to teach them the techniques that are common, and central, to any effective quantitative quality design and maintenance program. Applications involve both manufacturing and services; we will examine financial services in some detail. We will conclude with a discussion of the core concepts of Six Sigma.

Course Descriptions
70-476 Healthcare Management
Intermittent: 9 units
This course gives an overview of the key entities in the U.S. healthcare system and lays out the challenges and opportunities that healthcare executives face. We will identify the main components of the healthcare value chain and explore how they operate in an increasingly complex and dynamic environment. We will focus on how core quantitative management principles can be applied in design and analysis of an efficient healthcare system from operations, finance, and marketing perspectives and study the impact of strategic implementation of operations improvement programs. We will follow an integrated, hands-on approach providing opportunities to the students in finding ways to improve the management and delivery of healthcare in real-life settings.
Prerequisites: (36-202 or 36-208 or 70-208) and (70-371).

70-480 International Marketing
Spring: 9 units
This course is designed to provide students with a basic understanding of global marketing opportunities, key issues, and strategies. It introduces the main characteristics of international markets and addresses the impact of global environmental factors (economic, social, legal, and cultural) on marketing decisions such as market entry, product development, pricing, promotion, and distribution. The objective of the course is to help students acquire knowledge of major international marketing concepts and develop cross-cultural sensitivities and skills that would enable them to identify, analyze, and solve international marketing problems.
Corequisite: 70-381.

70-481 Marketing Research
Spring: 9 units
The purpose of this course is to teach multiple research techniques used in marketing. This course is an applied marketing course that gives insight into how various techniques are used in marketing research firms. There are three projects and a final. The first project is designed to teach students about research survey methods. The second is an experiment in which the whole class is involved. The third, an individual project, is designed to teach quantitative research techniques.
Prerequisites: 70-208 or 70-381 or 73-360.

70-483 Advertising and Marketing Communications
Intermittent: 9 units
This course is designed to help students develop an integrated marketing communications plan to build enduring brand values. Students will work in groups on developing a MarCom plan for a real company. Several marketing managers of the company will come to class, present background information about the company, and the brand/product that students will be working on. The course contains three parts: 1 — frameworks for brand management used to select target audiences and set communications objectives; 2 — the evaluation of alternative creative messages (e.g., YouTube videos), testing ad effectiveness, and assessing the effectiveness of the mix as a whole (traditional and non-traditional media); and 3 — non-traditional marketing tools such as social media, viral marketing, and event and guerrilla marketing.
Prerequisite: 70-381 Student Status: Junior
Prerequisite: 70-381.

70-485 Product and Brand Management
Spring: 9 units
In this course you will progress through a series of roles, from product assistant to group product manager, that give you the opportunity to experience what is is like to do product and brand management. Through interactive lectures, case discussions and assignments, you will learn how to conduct analysis and make decisions that face product managers in industry. This course covers consumer and business to business marketing, including brand strategy, new product introduction, pricing and product line profitability, distribution strategy, marketing communications integration, and brand/product portfolio management. Time is also spent on building effective internal, cross-functional and external customer and agency relationships. By progressing through case-based roles from product/brand assistant to group brand/product manager, you will learn the principles of product and brand management and understand what it is like, and what it takes, to be a successful marketing leader.
Prerequisite: 70-381.

70-486 Pricing
Spring: 9 units
The purpose of this course is to present a framework for assessing pricing decisions, the central element of marketing. The course is structured around marketing’s three Cs: Costs; Customers; and Competitors. In the first part of the course we discuss how costs should, and should not, enter the pricing decision. We move on to show how a marketing focus on the customer provides insight into the pricing decision. Then we discuss how competitors impact the pricing decision. The course concludes with pricing strategies, tactics and their applications: dynamic pricing over the product life cycle, product line pricing through the marketing channel, price bundling and legal aspects of pricing.
Prerequisites: (70-381 and (73-100 or 73-110).

70-487 Customer Management Using Probability Models
6 units
Forecasting is a critically important activity for all firms. This course provides simple but powerful models that use readily available purchasing data to capture underlying patterns in customer behavior. More importantly, learn how to use these models to provide accurate forecasts for what these customers will do in the future, as well as the right way to think about modeling customer activity. Using this way of thinking, it is possible to see that consistent behavioral patterns exist across different marketing channels (e.g., offline, online and catalog) and even across seemingly different domains (e.g., grocery and music). The tools are very general in their applications and can also be used for various Decision Analysis applications that manufacturing managers and consultants as well as information technology professionals are often faced with.
Prerequisite: 70-381 Student Status: Junior
Prerequisite: 70-381.

70-488 Interactive Marketing
All Semesters: 6 units
In this course we analyze what happens to marketing practice when cheap and powerful computers and communication networks are used to mediate markets. This course focuses on several areas where the presence of computers and networks are likely to have the most profound affect on the field of marketing. These areas include branding, promotion, competitive strategy, channel conflict, pricing and marketing information goods, and identifying and differentiating customers. We will use both lectures, cases, and analysis of real-world datasets to analyze these issues.
Prerequisite: 70-381.

70-492 Investment Analysis
Spring: 9 units
Students build a strong foundation in Modern Portfolio Theory as well as equilibrium and no arbitrage approaches to asset pricing. Common stocks and fixed income securities (including mortgage-backed securities) are the principal markets of interest, with tangential coverage of forward, option, and currency markets. Empirical projects entail applications of trading strategies, portfolio management, and the characteristics of financial market data.
Prerequisites: 21-370 or 70-391.

70-495 Corporate Finance
Fall and Spring: 9 units
Students develop an advanced financial perspective on how firms make investment, financing, and management decisions. The course starts with simple net present value rules and builds the theoretical framework to address more sophisticated issues and problems including risk management, mergers, acquisitions, executive compensation, corporate governance, and dividend payout policies. Theory is supplemented with numerous case study examples.
Prerequisites: 21-370 or 70-391.

70-497 Derivative Securities
Fall: 9 units
In this course students will learn to evaluate contingent claims such as options, futures, swaps and other exotic securities. In addition to covering canonical valuation formulae for standard option and future contracts, students will use numerical simulation methods to evaluate more exotic securities. The course will also cover various aspects of using derivative securities for risk management purposes.
Prerequisite: 70-492.

70-499 Internship
All Semesters
BA students are strongly encouraged to undertake internships. Students doing an internship of an academic nature do so under the supervision of a faculty member and receive a letter grade. Non-academic internships are possible for pass/fail credit with the approval of the Department Director. Enrollment by permission of the BA Program.
70-500 Honors Thesis I
Fall and Spring
Business students with outstanding academic records may undertake an Honors Thesis. The topic is of the student’s choice but must have some original aspect in the question being explored, the data set, or in the methods that are used. It must also be of sufficient academic rigor to meet the approval of a faculty advisor with expertise in the project’s area. Students enroll each semester in a 9-unit independent study course with their faculty advisor for the project (70-500 in the fall and 70-501 in the spring). Students and their faculty advisor develop a course description for the project and submit it for approval as two 9-unit courses to the BA department. Enrollment by permission of the BA Program.

70-501 Honor Thesis II
Spring
Business students with outstanding academic records may undertake an Honors Thesis. The topic is of the student’s choice but must have some original aspect in the question being explored, the data set, or in the methods that are used. It must also be of sufficient academic rigor to meet the approval of a faculty advisor with expertise in the project’s area. Students enroll each semester in a 9-unit independent study course with their faculty advisor for the project (70-500 in the fall and 70-501 in the spring). Students and their faculty advisor develop a course description for the project and submit it for approval as two 9-unit courses to the BA Director. Enrollment by permission of the BA Program.

70-502 Independent Study in Management
All Semesters
Students with a special interest in Management/Production not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA program.

70-503 Independent Study in Marketing
All Semesters
Students with a special interest in Marketing not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-504 Independent Study in Organizational Behavior
All Semesters
Students with a special interest in Organizational Behavior not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-505 Independent Study in Finance
All Semesters
Students with a special interest in Finance not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-506 Independent Study Management Information Systems
All Semesters
Students with a special interest in Management Information Systems not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-507 Independent Study in Business Communications
All Semesters
Students with a special interest in Business Communications not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-635 Desktop Publishing
Spring: 9 units
This course presents a variety of topics related to desktop publishing in a hands-on laboratory environment. The topics covered include PostScript, file formats, fonts, trapping, illustration programs, image processing programs, page assembly programs, imposition, preflighting, output issues to films, plates, or disk and an introduction to new media.

70-637 Interactive Media Design Management
Fall: 9 units
Applications of computer systems in creating and managing electronic print and new media projects, with emphasis on the latter in creating effective communication pieces. Goals are the ability to use desktop publishing applications, animations and authoring applications, and the ability to input and use different types of information, including text, photographs, illustrations, animations, sound effects and voice.

70-641 Color Reproduction and Management
Spring: 9 units
This course presents an in-depth view of the issues and technologies related to color reproduction. The theory, perception, specification and measurement of color are presented. Color separation techniques, color proofing, color management and the control of color production are all considered. Special effects and color manipulation are examined.

70-643 Publishing on the World Wide Web
Fall and Spring: 9 units
This course addresses topics related to the rapidly evolving area of WWW publishing, which has moved into the mainstream. Today, virtually every major newspaper, magazine, and book publisher has an active website. In addition, the Internet is used as a publishing medium by millions of other individuals and companies. In this course, the rush to WWW publishing is studied in context of the evolution of the internet; the lure of interactivity; the maturing desktop publishing revolution; and the continued development of tools and standards that lower the barriers to entry. The lecture topics encompass the history, technology, business applications and the design of materials to be published on the web. The course includes a lab component where the students perform individual and group projects to improve their design and applications skills.

70-650 Independent Study: Graphic Communications Management
All Semesters
Students with a special interest in Graphic Media not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

CFA Interdisciplinary Courses

62-010 Pittsburgh Filmmakers
Fall and Spring: 3 units
Any of Pittsburgh Filmmakers semester course offerings are available for registration through the CFA Dean’s Office. Visit www.pghfilmmakers.org for listings. Registration can only be done on or after your scheduled registration day. Spaces are limited. Stop by CPA 100 for details and to register.

62-100 Critical Histories of the Arts
Fall: 9 units
This course explores visual, material, literary and performing arts through case studies of a range of historical and geographical settings, emphasizing the west, but engaging a global scope: Classical, Renaissance, and Modern-European as well as Asian, African and Central American. Methods of inquiry stress both traditional notions of the humanities as essential manifestations of the human condition, and simultaneously, critical stances that prioritize economics, class, race and gender as inescapable issues in interpreting human creative production. Students will do weekly readings. Graded assignments will include both short writing assignments and collaborative creative work. The class will have a midterm and a final.

62-102 Modern Dance Workshop
Fall and Spring: 6 units
A modern dance class based on the philosophy of the Martha Graham technique. The class is designed to encourage exploration and discovery of the roots of physical movement and control. The class also covers fundamental and technical aspects of modern dance as a classical performing arts form.
62-141 Black and White Photography I
Fall and Spring: 10 units
This course will teach you the basic craft of photography from exposure of the negative through darkroom developing and printing to printing and presentation. Content includes student presentations, class discussions, shooting assignments, darkroom sessions and class critiques. We will concentrate not only on the technical aspects of photography, but also the aesthetics of seeing with a camera. The course concentrates on photography as a fine art — what is unique to it and the concerns that are shared with other visual arts, such as composition, tonal values, etc. and aims to equip students with an understanding of the formal issues and the expressive potentials of the medium. Lab fee and 35mm manual camera required. Each student is responsible for the cost of paper and film.

62-165 Mutable Landscape: Drawing and the Digital Photographic Image
Intermittent: 10 units
Through investigations of social & historical uses of photography and the landscape, students will develop their own portfolios of digitally informed, camera-based images. The class will leave the studio behind to explore, document and invent a sense of place in Pittsburgh. As a CFA Interdisciplinary class, students will be encouraged to consider implications of the landscape and image in the medium of their home department. Although the class will engage issues of medium and materiality, this is not a software class. Students should have some familiarity with the Mac. No prerequisites.

62-175 Descriptive Geometry
6 units
This is a manual construction course for solving problems in three-dimensional geometry through working with two-dimensional planes using basic mechanical drawing tools. The course covers basic concepts of descriptive geometry; solving problems involving lines and planes in space and their spatial relationships; rotations in three dimensions; locating points and tangents on solids and surfaces; intersection of solids; shades and shadows; perspectives; and development of surfaces.

62-190 BXA Freshman Research Seminar
Fall and Spring: 9 units
Section B of the BXA Freshman Research Seminar introduces first-year students to the field of interdisciplinary work and arts-based research. Students engage with theoretical and practical readings from across the various concentrations, with particular emphasis on aesthetic theory. Guest lectures complement the weekly readings by giving insight into practical implementations of these ideas. Students will conceive, research, and create a final project to be presented at the end of the semester. Section A of the BXA Research Freshman Seminar has been designed for internal transfer students and it is offered as a four-unit honors course. Using the arts as primary modes of inquiry, this course’s content probes the idiosyncratic field of arts-based research by following the principle that there is no aspect of human life that cannot be studied objectively, quantified and analyzed. Aside from discussing a digest of the latest writings on arts-based research, students will try their own approach to arts-based research by building prismatic artistic and literary constructs inspired by the reading of Italo Calvino’s Six Memos for the Next Millennium, Cosmicomics, and Invisible Cities.

62-205 Documentary Photography
Fall: 9 units
Documentary photography explores issues, often social, humanistic and/or political, in man-made culture. This course examines the work of many major nineteenth through twenty first century documentarians while students photographically investigate their own topics. Among the many ethical areas of a documentarian’s concern, the course examines (through looking at the documentary tradition and through the student’s own work) the following: the photographer’s relationship to the subject; the choices involved in representing the subject; the act of selectivity in framing the image; our goals are twofold: identification of photo theory as it applies to current practice from both the viewpoint of maker and consumer. The course is designed to address philosophical issues for photographers working now and will favor conversation over written work; students are expected to fully participate in critical analysis and discussions. Readings include works by Roland Barthes, Stephen Shore, Susan Sontag, Hollis Frampton, John Szarkowski, Robert Adams, Italo Calvino, Berenice Abbott, John Berger and James Elkins. No pre-requisites.

62-244 Contemporary Photo Theory
Intermittent: 9 units
Because, you know, the photographs are more a question than a reply (Sebastiao Salgado). A photograph is a moral decision taken in one eighth of a second, or one sixteenth, or one one-hundred-and-twenty-eighth (Salman Rushdie). This seminar investigates current topics in photography and the image; our goals are twofold: identification of photo theory as it applies to current practice from both the viewpoint of maker and consumer. The course is designed to address philosophical issues for photographers working now and will favor conversation over written work; students are expected to fully participate in critical analysis and discussions. Readings include works by Roland Barthes, Stephen Shore, Susan Sontag, Hollis Frampton, John Szarkowski, Robert Adams, Italo Calvino, Berenice Abbott, John Berger and James Elkins. No pre-requisites.

62-245 Portrait Photography
Intermittent: 10 units
Portrait Photography explores the emotional and visual process of collaboration between subject and photographer that creates a photograph. We’ll use cameras of all formats and levels of sophistication to create portraits in the studio and on location. We’ll find and exploit available light and create artificial light to complete our vision, and we’ll explore a wide range of darkroom strategies to support and add richness to our final print. Through film and video we’ll meet some of the masters of this form like Arbus, Newman, Avedon and Penn, and we’ll take advantage of any opportunities to visit exhibitions and photographers studios. Lab fee required. Prerequisites: 62-141 or 60-141 or 51-265.

62-247 Introduction to Hot Glass I
Fall and Spring: 3 units
For beginners with little or no hot shop experience, this class will emphasize safety, proper tool use, communication, and a team approach to glassblowing, while executing simple blown forms such as cups and bowls in clear glass. No previous glassworking experience required. Basic materials provided. Lab fee and 35mm manual camera required. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to register. Spaces are limited. Course fee is $275. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-250 Beginner Beadmaking
Fall and Spring: 3 units
If you’re fascinated by baubles, bangles and beads, this is the class for you. Learn the secrets of how beads are made at the torch in this introduction to the basic skills needed to make beads at the torch using Moreti (soft) glass. You will have a chance to make many glass beads to take home as you learn the basic skills of heating glass, applying it to a mandrel, and shaping it with tools. You will develop a round mandrel as well as alter shape and add decorative color such as dots, frits, trails and encasing. No experience is required and all materials are provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to sign up. Spaces are limited. Course fee is $162.50. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-251 Pendant Passion
Fall and Spring: 3 units
Amaze your family and friends with your new collection of borosilicate (hard) glass pendants. In this 8-week session, students will learn a new design technique every week, from compression, pin wheels, donut holes, mandrel beads and much more. Focus on flame development, gathering glass, color application of dots, stripes and color layers to obtain the desired look of your one of a kind pendant. Great for beginners or those with some flameworking experience with an interest in pendants. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to sign up. Spaces are limited. Course fee is $162.50. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-252 Marble Madness
Intermittent: 3 units
Losing your marbles? Find them again in this fun class that will have you mad for marbles. We will start small to gain confidence gathering and using a marble mold. Then you will learn a number of techniques to capture an image in a perfect sphere. We will also focus on layering colors on the exterior to create pinwheels and other designs. Then we will work our way up to larger marbles. No experience required, but advanced students can work on more complex marbles. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to sign up. Spaces are limited. Course fee is $162.50. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.
Course Descriptions

62-255 Imagery in Glass
Intermittent: 3 units
This 8-week class will be a survey working with several techniques in kilnformed glass and imagery. In this fast paced class students will learn techniques such as working deep, painting with light and the photo resist process as well as kiln theory while working with powders, high fire enamels, etching and sandblasting. Using layers of imagery, students will learn depth and explore density with these varied techniques. Fusing experience is not required. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to register. Spaces are limited. Course fee is $205. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-256 Introduction to Coldworking
Fall and Spring: 3 units
In this class you will gain a basic knowledge of coldworking. It is structured for students who have previous glass experience and also those who are just looking for a start in the glass world. Lessons will include how to bring an object to a polish, cutting, carving, basic glueing, laminating, sandblasting and angle grinding. Several projects will be completed during this class, including coldworking bottles into cups and grinding and polishing a piece of cast glass into a beautiful cube paperweight. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please register for this course in person at CFA Room 100. Spaces are limited. Course fee is $122.50. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-265 Alternative Photo Processes
Spring: 10 units
This experimental photo-printmaking hybrid introduces students to 19th century, non-silver and alternative photographic printing techniques. One-of-a-kind, hand-applied processes include: Van Dyke, cyanotype, salted paper, POP, albumen, platinum & palladium and bromoil. Students will produce large format imagery by use of traditional large format shooting, analogue negative enlarging and/or digital negative methods. In addition to the printing techniques, the class considers how to unite process with concept. 
Prerequisites: 62-141 or 60-141 or 51-265.

62-267 Constructed Visions
Intermittent: 10 units
This studio course explores directed, manipulated, and constructed photography and is designed to further develop the conceptual thought surrounding image-making. Drawing upon the mediums of sculpture, painting and theater, this course takes photography beyond the camera. The class will investigate this tradition in the history of photography, from the first constructed images by Hippolyte Bayard and Oscar Rejlander, to the contemporary work of Cindy Sherman, Bruce Charlesworth, and Laurie Simmons. As students explore both fiction and non-fiction through photographs, we will look at the interesting interplay between words and photographic images; how images are paced and scaled to create tempos; how photographs are sequenced to tell stories; and other formal elements involved in creating visual narratives. Prerequisite: a college level photography course or consent of instructor.

62-269 Modern Ruin
Intermittent: 10 units
Modern Ruin will afford photographers an opportunity to investigate places, buildings, moments in time, and people, mostly ignored and abandoned, that have often ended up in society's wastebasket. Class members will have opportunities to choose their area of interest, engage these subjects and allow themes to emerge and evolve. Each photographer will devise strategies to make photographs that support their vision. Emphasis will be on refining the process of discovery, finding and making light, and exploiting every resource to make photographs, on location, under difficult conditions. Good darkroom skills are essential - each student will make images using printing and processing techniques that support their vision. The class may take field trips to visit museums and galleries, invite guest speakers from many disciplines, and watch films and videos to augment each photographer's individual investigations. Prerequisites: Black & White I (62-141) or consent of instructor.

62-300 Filmothea: Seminar in Film Music
Summer: 9 units
The themes of the course include the representation of history in literature and film, realism and the fantastic, ideology and political power, the role of the individual in society, eroticism and the social structure, and gender roles. Through reading the original novels, constructing a version of the film scripts, and viewing the films, students consider European response to the works studied, and explore the question of literary adaptation from text and film.

62-337 Studio Lighting
Intermittent: 10 units
This course provides a working knowledge of studio-based lighting techniques. Students will create photographs using artificial light- both "hot" lights and electronic flash units. Assignments will include table-top/still life and portraiture. Students can use cameras of any format to complete assignments, but class instruction will emphasize the use of 4X5 cameras that are available to all studio lighting students. To successfully complete assignments students will be required to purchase paper, film, and 4X5 Polaroid film, or create images using digital capture. The class may visit off-campus galleries and museums, and will invite photographers for special presentations. Grading is based on attendance, assignment critiques, and the final portfolio.

62-347 Hot Glass II
Fall and Spring: 3 units
Students will refine and vary the cup and bowl shape in the first few weeks. Proficiency and efficiency in working the glass will be emphasized before moving on to more complex shapes. Some basic methods of color application will be explored, and students will learn to recognize and trouble-shoot common problems. 24 hours of hot glass class/workshop experience required, or by permission of the instructor. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CPA 100 to register. Spaces are limited. Course fee is $275. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.
62-350 Art Money and Power in History: China vs. the West

Intermittent: 9 units
How have artists made money across history and region? How did money and power influence their creative careers? The purpose of this course is to explore art in its economic and political context in China and in the West with data from art history, economic history, and political history. It will examine six important periods in art history in the West: Classical Athens, early Renaissance in Florence, Dutch Republic in the 17th century, France in the 18th and 19th centuries, and the United States of America since 1945. They will be compared with China in the Qin, Song, Ming, Qing dynasties, China under the Western Invasions from 1840 to 1950, and contemporary China. While arguing that artists' talent, not money or power, produced art, we believe that, when studied comparatively, art is an integral part of the society.

62-358 Art and Biology

Intermittent: 9 units
A studio-laboratory art-making course designed to explore interactions between art and biology. It is an opportunity for students interested in interdisciplinary concepts to work both in a studio art environment and a biological laboratory. Students have the opportunity to experiment creatively with scientific media such as electron and video-probe microscopy.

62-360 Photographers and Photography Since World War II

Spring: 9 units
Photographers and Photography since World War II. This course explores in depth the work of significant imagemakers W. Eugene Smith, Helen Levitt, Diane Arbus, Robert Frank, Minor White, William Wegman, Cindy Sherman, Vik Muniz and others while simultaneously looking at trends in the world of photography over the past 50 years. Several class sessions will be held off-site, including one evening at the Andy Warhol Museum and another at Silver Eye Center for Photography.

62-371 Photography, The First 100 Years

Fall: 9 units
Photography was announced to the world almost simultaneously in 1839, first in France and then a few months later in England. Accurate " likenesses" of people were available to the masses, and soon reproducible images of faraway places were intriguing to all. This course will explore the earliest image-makers Daguerre and Fox Talbot, the Civil War photographs organized by Mathew Brady, the introduction in 1888 of the Kodak by George Eastman, the critically important social documentary photography of Jacob Riis (How the Other Half Lives: Studies Among the Tenements of New York) and his successor, Lewis Hine, the Photo-Secession of Alfred Stieglitz, the Harlem Renaissance of James VanDerZee, the precisionist f64 photographers Ansel Adams, Imogen Cunningham, and Edward Weston, and a host of other important photographers who came before World War II. The class will be introduced to 19th century processes, such as the daguerreotype, tintype, and ambrotype, as well as albumen prints, cyanotypes, and more. Two field trips will take place during class, one to the Frick Art & Historical Center and one to The Carnegie Museum of Art. No prerequisites.

62-375 Large Format Photography: The Antiquarian Avant-Garde

Intermittent: 10 units
This course takes part in the anti-social movement by exploring the roots of photography. Students will shoot with an array of large format cameras and use 19th and 20th century processes to create "one-of-a-kind" photographic images. Course topics include non-silver printing processes, pinhole photography, and contemporary tint-types. Prerequisites: 60-141/62-141/ equivalent or consent of instructor.
Prerequisites: 62-141 or 60-141 or 51-265 or 62-241 or 62-265.

62-381 Color Photography and Digital Output

Fall and Spring: 10 units
This is a course using digital photography with digital printing methods. Students will gain an understanding of color theory and aesthetics, while better defining their individual voices. By semester's end, students will have a finely printed body of work using Mac OS, RAW file handling, color management and Adobe Photoshop. Prerequisites: 62-141 or consent of instructor.
Prerequisites: 51-265 or 60-141 or 62-141.

62-390 BXA Undergraduate Research Project

All Semesters
The BXA Undergraduate Research Project is for students who want to work on a self-designed project with the one-to-one guidance of a faculty advisor. The project should be interdisciplinary in nature, and can be a scholarly and/or creative endeavor. The project may take the form of a written thesis, a compilation of creative works, an outreach project, etc. The project topic must be pre-approved by the faculty member who agrees to supervise the project and assign a letter grade for the course. Projects are to be completed in one semester, may be worth 3, 6, 9, or 12 units of academic credit, and cannot be taken concurrently with the BXA Capstone Project during the senior year. To register, students must submit an "Undergraduate Research Project Proposal Form" signed by both the student and the faculty advisor, along with a proposal, to the BXA Associate Director/Academic Advisor.

62-391 BXA Junior Portfolio Review

Spring
To better assess the progress and accomplishments of BXA students as they enter their final year, students submit a portfolio for review during the spring semester junior year. Students should work with their BXA advisor and their concentration faculty advisors to assemble a portfolio that represents their academic and creative accomplishments over the course of their college career. This portfolio should also include a reflective essay in which students evaluate how they integrated their two areas of interest, and how they will extend that integration into the BXA Capstone Project in the senior year. Students should identify their own specific goals for their academic career and how they are fulfilling them in this reflective essay, as well as how they evaluate their performance in light of the programs' broader pedagogical goals. Students in the BXA program should be working toward being able to: describe the connections between their chosen concentration disciplines and to integrate them into their work; communicate ideas in writing, visual expression, and oral expression; discuss the intersection of history, society, and culture from local and global perspectives; synthesize mathematical theories and experimental work to produce real-world knowledge; and use cognitive, behavioral, and ethical dimensions to make decisions on individual and social levels.

62-400 BXA Capstone Project

All Semesters: 9 units
The BXA Capstone Project gives BXA students the opportunity to demonstrate the extent of their interdisciplinary work over the course of their academic career. The Capstone Project should include elements that span the student's CFA and DC concentrations (for BHA students), CFA and MCS concentrations (for BSA students), or DFA and SCS concentrations (for BCSA students). The project can be either a scholarly or creative endeavor, and may take one of many possible forms (e.g., a written thesis, a compilation of creative work or works, an experiment and report, a computer program or animation, etc.). The BXA Capstone sequence covers both semesters of a student's senior year. In the fall, students are enrolled in 62-401 BXA Capstone Project I (9 units); which meets weekly to discuss strategies for managing research, planning the project, and larger theoretical issues related to interdisciplinary work. At the end of the fall course, students will have produced a Capstone Project proposal, an annotated bibliography, and multiple versions of their project pitch. In the spring, students enroll in 62-402 BXA Capstone Project II (9 units), which has no required classroom time. Instead, students spend the semester doing the research and foundational work necessary for the project, as well as meeting with their faculty and BXA advisors as they create their Capstone Project and prepare to present it at the annual Meeting of the Minds Undergraduate Research Symposium held each May. Students will only be enrolled in 62-400 (9 units) when they are unable to complete a two-semester sequence and need to gain special permission by the BXA Associate Director/Academic Advisor.
62-401 BXA Capstone Project
Fall: 9 units
The BXA Capstone Project gives BXA students the opportunity to demonstrate the extent of their interdisciplinary work over the course of their academic career. The Capstone Project should include elements that span the student’s CFA and DC concentrations (for BHA students), CFA and MCS concentrations (for BSA students), or CFA and SCS concentrations (for BCSA students). The project can be either a scholarly or creative endeavor, and may take one of many possible forms (e.g., a written thesis, a compilation of creative work or works, an experiment and report, a computer program or animation, etc.). The BXA Capstone sequence covers both semesters of a student’s senior year. In the fall, students are enrolled in 62-401 BXA Capstone Project I (9 units), which meets weekly to discuss strategies for managing research, planning the project, and larger theoretical issues related to interdisciplinary work. At the end of the fall course, students will have produced a Capstone Project proposal, an annotated bibliography, and multiple versions of their project pitch. In the spring, students enroll in 62-402 BXA Capstone Project II (9 units), which has no required classroom time. Instead, students spend the semester doing the research and foundational work necessary for the project, as well as meeting with their faculty and BXA advisors as they create their Capstone Project and prepare to present it at the annual Meeting of the Minds Undergraduate Research Symposium held each May.

62-402 BXA Capstone Project
Spring: 9 units
The BXA Capstone Project gives BXA students the opportunity to demonstrate the extent of their interdisciplinary work over the course of their academic career. The Capstone Project should include elements that span the student’s CFA and DC concentrations (for BHA students), CFA and MCS concentrations (for BSA students), or CFA and SCS concentrations (for BCSA students). The project can be either a scholarly or creative endeavor, and may take one of many possible forms (e.g., a written thesis, a compilation of creative work or works, an experiment and report, a computer program or animation, etc.). The BXA Capstone sequence covers both semesters of a student’s senior year. In the fall, students are enrolled in 62-401 BXA Capstone Project I (9 units), which meets weekly to discuss strategies for managing research, planning the project, and larger theoretical issues related to interdisciplinary work. At the end of the fall course, students will have produced a Capstone Project proposal, an annotated bibliography, and multiple versions of their project pitch. In the spring, students enroll in 62-402 BXA Capstone Project II (9 units), which has no required classroom time. Instead, students spend the semester doing the research and foundational work necessary for the project, as well as meeting with their faculty and BXA advisors as they create their Capstone Project and prepare to present it at the annual Meeting of the Minds Undergraduate Research Symposium held each May.

62-446 Hot Glass III
Fall and Spring: 3 units
This class will touch upon a broad range of more complicated techniques including use of solid color, mold blowing, and compound shaping. Students will be encouraged to focus on directions that interest them, and will continue to refine basic skills and methodology. This class can be repeated; content will vary by session. 48 hours of hot glass class/workshop experience required, or by permission of the instructor. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is $275. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-447 Hot Glass III Open Projects
3 units
There will be no weekly demonstration by the instructor. Students in this class will be encouraged to pursue their own ideas and maximize the available work time each week. 48 hours hot glass class/workshop experience required, or by permission of the instructor. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is $287.50. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-450 Flame I
Fall and Spring: 3 units
A great combination class to explore the variety in flameworking. Students will work with both Moretti (soft) and borosilicate (hard) glass, to create and manipulate simple forms in the flame such as beads, marbles, and sculptural elements, and will explore techniques including pulling points and blowing. No glass working experience is required. All materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is $162.50. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-452 Flame II- Blowing Boro
Intermittent: 3 units
This class will start with a review of pulling points and blowing simple hollow forms and expand into the creation of small vessels including jars and perfume bottles. Techniques covered will include welding and encalmo, and various cane and color applications. Flameworlking I or 24 hours experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. There is a $162.50 Course Fee. Spaces are limited. Not eligible for PCHE Cross-Registration. Course taught at the Pittsburgh Glass Center.

62-453 Fusing and Slumping
Fall and Spring: 3 units
Come and learn the ancient, beautiful and fun art of fused and slumped glass. A blend of art and science, this course will be an overview of glass compatibility and lamination as well as fusing and slumping techniques. Utilizing heat, gravity and time, students will be guided through the process via lectures and demonstrations. No glass working experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course Fee is $205. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-455 Kiln Casting
Fall and Spring: 3 units
Students will be introduced to the art of kiln casting through the creation of small objects including sculptures and non-functional vessels out of glass using a variety of mold making and kiln casting techniques. This class will cover constructing models, making refractory molds, preparing the glass, firing the molds in kilns and resolving castings into finished works of art. No glass working experience required. All basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course Fee is $205. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.
62-456 Fused and Slumped Glass-Phase II
Fall and Spring: 3 units
Now that you have a basic knowledge of fusing, let’s ramp it up. This class is about pushing the materials into the two dimensional realm. We’ll work deep, using powders and multiple layers to create imagery in glass; cover kiln casting and mold making as well as more advanced cold working techniques. And we’ll get a little crazy creating our own patterned glass in the form of pattern bars and a variety of other techniques. 24 hours of fusing class/workshop experience required, or permission of the instructor required. Basic materials provided and additional materials can be purchased from Pittsburgh Glass Center. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please register in person at CFA 100. Spaces are limited. Course Fee is $205. Not eligible for PCHE cross registration. Course taught at Pittsburgh Glass Center.

62-459 Stained Glass
Fall and Spring: 3 units
Students will learn the art of stained glass through pattern making, cutting, foiling and framing to create a stained glass window. Both historical and contemporary designs and approaches will be used and the plethora of stained glass windows in Pittsburgh will be fodder for inspiration. Whether your interest is in traditional windows or something totally cutting edge this class is for you. Students will design and construct their own window for the final project. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please register for this course in person at CFA Room 100. Spaces are limited. Course fee is $175. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-483 Growing Theatre Community Outreach
Fall and Spring: 6 units
Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students’ personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU. This course is open to all students, not just Drama majors.

62-590 BXA Internship
All Semesters
An internship is a supervised professional work experience with clear links to a student’s academic goals. BXA students may choose to complete a BXA Internship for elective credit with appropriate individuals or organizations within or outside of Carnegie Mellon University. Junior and senior BXA students in good academic standing are eligible to receive academic credit for one internship. Grading is pass/no pass only. Prior to enrolling in an internship, the student must have a “BXA Internship Agreement Form” signed by their site supervisor and approved by the BXA Associate Director/Academic Advisor.

62-661 Interaction and Expression using Pausch Bridge Lighting
3 units
Working in cross-disciplinary teams, students will explore light as art, interactive design and programming using a Pharus lighting control system. Students will explore the use of light and interaction using the actual controls within the Randy Pausch Memorial Bridge. Student teams will develop final projects that will be exhibited on the actual Randy Pausch Memorial Bridge.

CIT Interdisciplinary Courses
39-100 Special Topics: WHAT IS ENGINEERING?
Fall: 9 units
What is Engineering? In today’s world, we are so used to technology, helping us yet giving rise to complex problems, our friend and yet sometimes our challenge in preserving all that is human. This course is an introduction to all students about what engineers do and how they do it. It is about the culture, the thinking, the creativity and more than anything else, the doing which is at the heart of engineering. On a more pragmatic level, our world of ever-increasing technological complexity demands that everyone is to some extent familiar with things technical. William A. Wulf, President of the National Academy of Engineering, has said that a public that is technologically less than literate and unable to understand technical decisions is left to trust that good decisions will be made on their behalf. We invite you to take this course to get a feeling for what engineers experience in their work and bring out the creativity in each of you. The goal of this course is to help Carnegie Mellon students of all disciplines understand the role and impact of engineering in modern society and participate in the excitement of engineering. Demonstrations and hands-on projects will give students the experience of what engineers do. After completing this course you will have a better understanding of the contributions of engineering to our society, how engineers see and think about the world, what the “big issues” for engineers are, what’s involved in the different fields of engineering, and the tools engineers use. The multi-disciplinary and collaborative nature of almost all engineering work will be stressed. 39-100 is open to first through third year students in all majors except engineering.

39-200 Business for Engineers
Fall and Spring: 9 units
This course is intended to prepare CIT graduates for the fast paced world of modern industry. There have been paradigm shifts that complicate career selection and compound the difficulty of becoming a productive member of an organization. Graduates of a technical program can benefit from an understanding of modern business concepts when they begin their careers. The content of this course will include both specific financial analysis topics and certain business administration topics such as program management, entrepreneurship and ethics. Students will become familiar with analyzing financial statements, stock market reports and stock options while developing their verbal and written presentation skills.

39-245 Rapid Prototype Design
All Semesters: 9 units
This course provides an introduction to rapid design through virtual and physical prototyping. The class covers the engineering design process, problem solving methods, interdisciplinary team work, current industrial practice, and manufacturing process capabilities. The course emphasizes hands on learning. Sophomores have priority while registering for this course. Juniors and seniors will be put on the waitlist, then released once sophomores have registered.

39-250 CIT Undergraduate Projects
Fall
This course number is to be used for Fall CIT freshman research projects only. Student must complete a CIT Undergraduate Project Approval form (located in Scaife Hall 110) and submit for approval. The form must include a complete description and a signature approval from the research advisor/instructor. If the project is approved, the CIT Undergraduate Studies Office will add the course to the student’s fall schedule.

39-251 CIT Undergraduate Projects
Spring
This course number is to be used for Spring CIT freshman research projects only. Student must complete a CIT Undergraduate Project Approval form (located in Scaife Hall 110) and submit for approval. The form must include a complete description and a signature approval from the research advisor/instructor. If the project is approved, the CIT Undergraduate Studies Office will add the course to the student’s fall schedule.
39-399 Special Topics: Land Revitalization in the New Global Economy
Spring: 3 units
In this seminar course, we will explore the US process for land revitalization and compare it to the causes and remedies found in China. The results will provide context for a better understanding of global land management challenges that require a balance between the culture, the economy and the environment. The centerpiece of the course is a spring break, 9-day trip to China, visiting the cities of Hong Kong, Shenzhen and Guangzhou, while hearing from local academics and practitioners that are working on land revitalization projects. Students will participate in pre- and post-trip lectures (with some required reading) and will submit a final paper summarizing the regulatory and cultural differences between the US brownfield development process and the sites visited in China. There are no prerequisites. The course is open to juniors, seniors and graduate students and is most pertinent to students in civil and environmental engineering, public policy, architecture, and land use planning.

39-447 CIT Undergraduate Interdisciplinary Design Project
All Semesters
39-447 CIT Undergraduate Interdisciplinary Design Project 3-24 units
This course is to be used for undergraduate research projects involving a significant interdisciplinary design component. It can be added by permission only through collaboration with the student, project advisor, and the CIT Dean’s Office. For projects that are not interdisciplinary in nature, students should refer to the research number specific to the department in which the research is being completed.

39-499 Summer Curricular Practical Training
Summer: 3 units
The college of engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is an internship, normally completed during the summer. Students do not need to officially register for an internship unless they want it listed on their official transcripts. CIT students interested in registering their internship for course credit on their transcript may enroll in this course. To do so, students must complete a CIT Internship form (located in Scaife Hall 110) and submit for approval. The CIT Undergraduate Studies Office will add the course to the student’s schedule, and the student will be assessed tuition for 3 units. Upon completion of the internship, students must submit a 1-2 page report of their work experience, and a 1-2 page evaluation from the company supervisor to the CIT Undergraduate Office. After the reports has been reviewed and approved, a “P” grade will be assigned. This process should be used by international students interested in Curricular Practical Training (CPT) or by any other engineering undergraduate wishing to have their internship experience reflected on their official University transcript. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE’s website.

39-500 Honors Research Project
All Semesters
Juniors who have an accumulated GPA of at least 3.5 receive an invitation to participate in the program. This course, open by invitation only, will provide the opportunity for close interaction with a faculty member through independent honors research in a number of disciplinary and interdisciplinary areas, as part of the CIT Honors Research Program. Students will work on their projects during their senior year, earning the equivalent of 18-24 units. Students are required to register for CIT Honor Research Project 39-500. To receive CIT College Honors, a student must complete at least 18 units in 39-500 on the same research topic. Students are also required to participate in the CIT poster competition at the Undergraduate Research Symposium, “Meeting of the Minds,” a university-wide celebration of undergraduate research.

39-600 Integrated Product Development
Fall: 12 units
The IPD course focuses on team-based integrated product development among engineering, business, and design disciplines. The course is open to seniors and graduate students in engineering, industrial and communication design, and MBA students. The course generally has about a dozen students from each discipline. The course consists of four modules including identifying, understanding, conceptualizing and introducing a product opportunity. In recent years we have partnered with industrial sponsors to address a customer opportunity, resulting in patent applications. The emphasis in the course is on the early, “fuzzy” stage of product development. The course gives structure to these stages and helps direct the process to be more efficient and effective. Students project to produce four phase written and oral reports. At the end of the semester the team will develop a form prototype, function prototype, marketing plan and manufacturing plan for the product. This course has gained an international reputation as a leading course in new product development. Course admission by permission of professor only; all students will be waitlisted until admission decisions are made. Students should contact the professor for an application for the course.

39-605 Engineering Design Projects
Fall: 12 units
In this project course, students work in multidisciplinary teams to design products or processes. The course is open to juniors, seniors and graduate students from all parts of the campus community. Each project is sponsored by an industry, government or non-profit partner, and is of real commercial interest to that partner. Students work directly with their partners throughout the semester to establish goals and requirements, evaluate their design as it progresses, and produce a final report, presentation, and, if appropriate, a prototype. Design reviews, held twice during the semester, give students a chance to present their preliminary designs and receive feedback and advice. In completing their designs, teams must consider not only the functionality of their designs, but also the look, feel, appearance, and societal impact. Skills built in this course will include: developing the product statement, establishing goals and constraints for the product, project management, and generating and evaluating design alternatives. As some projects may span multiple semesters with new groups of students, careful documentation of project work is emphasized. Students may take this course for either one or two semesters.

39-606 Engineering Design Projects
Spring: 12 units
In this project course, students work in multidisciplinary teams to design products or processes. The course is open to juniors, seniors and graduate students from all parts of the campus community. Each project is sponsored by an industry, government or non-profit partner, and is of real commercial interest to that partner. Students work directly with their partner throughout the semester to establish goals and requirements, evaluate their design as it progresses, and produce a final report, presentation, and, if appropriate, a prototype. Design reviews, held twice during the semester, give students a chance to present their preliminary designs and receive feedback and advice. In completing their designs, teams must consider not only the functionality of their designs, but also the look, feel, appearance, and societal impact. Skills built in this course will include: developing the product statement, establishing goals and constraints for the product, project management, and generating and evaluating design alternatives. As some projects may span multiple semesters with new groups of students, careful documentation of project work is emphasized. Students may take this course for either one or two semesters.

39-647 Special Topics in Design
All Semesters
This course is to be use for Interdisciplinary Engineering Design Independent Study. It can be added by permission only through collaboration with the student, Independent Study project advisor, and the CIT Dean’s Office.

39-648 Rapid Design and Prototyping of Computer Science
Spring: 12 units
This course deals with rapid prototyping, manufacture, and applications of a new generation of wearable computers, with head-mounted display. The design of wearable computers is a multidisciplinary process including: Electronic design, mechanical design, software development, and human-computer interaction. Two classes of wearable computers will be further developed: embedded, custom designed VuMan series, and general purpose Navigator series. Electronic design includes the custom designed computer board, electronic interfacing, and power supply. Industrial designers and mechanical engineers team to design and manufacture with in-house facilities a variety of conformable/lightweight housings. A software development environment and user interface builders and software and application development. Current applications include: Global Positioning, Hypertext documents, speech recognition, wireless communications, and digital imaging.
Carnegie Mellon University

Carnegie Mellon University-Wide Studies Courses

99-101 Computing @ Carnegie Mellon
Fall and Spring: 3 units
Computing@Carnegie Mellon (C@CM) is a 3-unit, pass/fail mini course that will help you develop foundational computing and information literacy skills, focusing on the tools and technologies that are specific to Carnegie Mellon so you can be successful in your other academic courses. All undergraduate students are required to take the course. C@CM is offered in a hybrid format through the Open Learning Initiative’s (OLI) online course environment; allowing you to complete the course as quickly as possible and on your own time. Although the course can be completed independently, there are a number of requirements and support services that require your physical attendance. The course runs for half of the semester and meets once a week for 50 minutes. Students must pass the course with at least a 75% grade based on a final exam. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-102 Computing @ Carnegie Mellon
Fall and Spring: 3 units
Computing@Carnegie Mellon (C@CM) is a 3-unit, pass/fail mini course that will help you develop foundational computing and information literacy skills, focusing on the tools and technologies that are specific to Carnegie Mellon so you can be successful in your other academic courses. All undergraduate students are required to take the course. C@CM is offered in a hybrid format through the Open Learning Initiative’s (OLI) online course environment; allowing you to complete the course as quickly as possible and on your own time. Although the course can be completed independently, there are a number of requirements and support services that require your physical attendance. The course runs for half of the semester and meets once a week for 50 minutes. Students must pass the course with at least a 75% grade based on a final exam. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-103 Computing @ Carnegie Mellon
Fall and Spring: 3 units
Computing@Carnegie Mellon (C@CM) is a graduation requirement for all undergraduate students. This 3-unit, pass/fail course is primarily comprised of Carnegie Mellon-specific information. It is intended to help students understand what resources are available as well as their responsibilities as users in our computing community. The course runs for half of the semester and meets twice a week for 50 minutes. Students must pass the course with at least a 75% grade based on exams, homework assignments, a group presentation and attendance. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-104 Carnegie Skills Workshop
All Semesters: 3 units

99-200 Tutoring, Mentoring and Role Modeling—A Community Service Course
Spring: 9 units
99-200 Tutoring, Mentoring and Role Modeling—A Community Service Course This course has service, intellectual, and personal goals. Its service goal is to provide effective tutors, mentors, and role models to local public school children. Students meet for class once/week and tutor 26 hours during the semester in programs that provide an opportunity to share talents and skills in the community. To promote effectiveness, the course includes topics of tutoring (making tutoring interesting and creative, focusing on meta-learning strategies and study skills); mentoring (exploring multiple mentoring models and the mutual benefits of a mentoring relationship); and informed citizenship (gaining a broader understanding of the issues that urban kids face, exploring how public policies affect the disparities between urban and suburban school student performance. The course also investigates the reasons that “supplemental educational services” are a $27 billion/year industry in the United States — Why are so many students in need of extra help? Tutors learn that they can be effective in helping younger students, and that it is personally rewarding to do so, and express that it is refreshing to step outside the grind of Carnegie Mellon life and do something meaningful in the community.

99-238 Materials, Energy and Environment
Fall: 9 units
The survival of humans and the advancement of civilization and culture are a result of mankind’s continued development of materials. From early times, civilizations with the most advanced materials have dominated the history of warfare and for the introduction of developments that have outpaced all others. As a result, materials have been influential in the trade and commerce between societies and are still to this day, strongly involved in the political, economic and social conflicts worldwide. Materials do not stand alone in development however, they are a result of, or are influenced by, technological needs and developments. The more advanced the material, the more energy and effort is required for its production. In the US, the production of materials accounts for about 90% of the country’s energy usage. This fact clearly indicates a strong tie between materials and energy, and without any energy, technological developments based on material advancement will not occur. In our world today, the need to provide improved performance, economics and design in consumer goods comes as a direct result of the market conditions established by consumers. Material selection and design therefore is driven by application and consumer needs which implies that the consumer has a large influence on material consumption. Material selection and material usage in turn have major ecological implications in energy, material resources and direct environmental impact. Awareness of the complicated interaction is paramount for continued development of civilization. With the scale of industrialization that exists on our planet, consideration of resource management, ethical material selection choices, energy management, and final disposal are all necessary to ensure a sustainable future.

99-241 Revolutions of Circularity
Fall: 9 units
In this course we will investigate how the apparently simple concept of circularity (both in stillness and in motion) has accreted meaning. Starting with the circle as presented in early geometry, we will encompass circularity in art and as a central issue in natural philosophy and the arts. We will also discuss appearances of the circle in literature, philosophy, and art since our study will reveal connections such as how Aristotle’s views on the nature influenced Ptolemy and an understanding of our place in relation to the world, including central imagery in the poetry of Donne. As we demonstrate proofs and analyze texts, circularity will emerge not only as a device through which intellectual revolutions have occurred, but also as an object that has itself been transformed over the centuries.

99-242 Meaning Across the Millennia
Spring: 9 units
Is it possible to convey messages that remain comprehensible after immense time, in the face of inevitable cultural shifts and physical decay? In this course, students will come to terms with the technical and philosophical aspects to this problem while working on group projects to propose solutions to the preservation of memory. Along the way, we will identify the challenges in extracting meaning from artifacts, both ancient and contemporary, such as documents and monuments, whether intentional or unintentional. We will also confront ethical and esthetic issues in identifying what is worth preserving, the challenge of societal pressures on past projects, the possibility of our future indifference, and the question of whether this endeavor may serve for present-day humanity. Case studies will include time capsules such as those created by the Westinghouse Electric & Manufacturing Company for the 1939 and 1964 New York World’s Fairs; the proposed waste management system for the U.S. Department of Energy Waste Isolation Pilot Plant; the Voyager Golden Records launched aboard two interplanetary probes; and attempts at communication with extraterrestrial intelligence.
99-250 Seminar for Peer Tutors
Fall and Spring: 4.5 units
SPECIAL PERMISSION REQUIRED: YES The purpose of this training course is to provide undergraduates with the knowledge, skills, and experience necessary to become effective Peer Tutors. Throughout the course, students will be exposed to the mission and goals of Academic Development and the Peer Tutoring Program. The class lasts approximately nine weeks and is generally offered in the spring term from February through April. The course explores the roles and responsibilities of the tutor while offering insights into effective tutoring strategies through interactive discussion and role play. In addition, trainees work hands-on with experienced tutors to troubleshoot potential problems and situations. Students will gain experience in group dynamics, communication skills, study strategies, referral resources, leadership, and creating a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically at (http://www.cmu.edu/acaddev/studentjobs/peertutor.html) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications. PLEASE NOTE THAT “SECTION W” IS FOR THE QATAR CAMPUS ONLY!

99-251 Seminar for Supplemental Instruction
Fall and Spring: 4.5 units
SPECIAL PERMISSION REQUIRED: YES The purpose of this training course is to provide undergraduates with the knowledge, skills and experience necessary to become effective Supplemental Instruction (SI) Leaders. Throughout the course, students will be exposed to the mission and goals of Academic Development and the Supplemental Instruction Program. The class lasts approximately nine weeks and is generally offered in the spring term from February through April. Course participants will actively explore collaborative learning instructional practices, learning theory, group dynamics, study strategies, and communication and leadership skills in order to create a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically at (http://www.cmu.edu/acaddev/studentjobs/sileader.html) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications.

99-252 Seminar for Academic Counseling
Fall and Spring: 4.5 units
SPECIAL PERMISSION REQUIRED: YES The purpose of this training course is to provide undergraduates with the knowledge, skills and experience necessary to become effective Academic Counselors (AC’s). Throughout the course, students will be exposed to the mission and goals of Academic Development and the Academic Counseling Program. The class lasts approximately nine weeks and is generally offered in the spring term from February through April. Students will gain experience in effective and efficient study strategies, learning theory, communication skills, group dynamics, referral resources and how to create a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically at (http://www.cmu.edu/acaddev/studentjobs/academiccounselor.html) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications.

99-415 Internship in Educational Outreach
All Semesters

99-451 Building Fluency for Presentations: A class for nonnative English speakers
Fall and Spring: 4.5 units
Building Fluency for Presentations: A class for nonnative English speakers (NNES) is a 4.5 unit pass/fail mini designed to prepare undergraduate NNES to deliver effective oral presentations. The course will help students become familiar with the expectations of the US style of presenting and will offer opportunities to practice giving presentations on academic topics. Students will focus on developing a broad range of skills, including the ability to: 1) communicate clearly with an audience in academic English; 2) employ linguistic features such as stress, intonation, and nonverbal cues to clarify and emphasize information; 3) consider various organizational strategies; 4) assess speaking strengths and weaknesses; and 5) feel comfortable in the role of presenter. Prerequisite: Permission from the Intercultural Communication Center (ICC). Please call the ICC at 412-268-4979.

Center for the Neural Basis of Cognition Courses

86-375 Computational Perception
9 units
This course, we will work first the biological and psychological foundational knowledge of biological perceptual systems, and then apply computational thinking to investigate the principles and mechanisms underlying natural perception. The course will focus on vision this year, but will also touch upon other sensory modalities. You will learn how to reason scientifically and computationally about problems and issues in perception, how to extract the essential computational properties of those abstract ideas, and finally how to convert these into explicit mathematical models and computational algorithms. Topics include perceptual representation and inference, perceptual organization, perceptual constancy, object recognition, learning and scene analysis. Prerequisites: First year college calculus, some basic knowledge of linear algebra and probability and some programming experience are desirable.

Chemical Engineering Courses

06-100 Introduction to Chemical Engineering
Fall and Spring: 12 units
We equip students with creative engineering problem-solving techniques and fundamental chemical engineering material balance skills. Lectures, laboratory experiments, and recitation sessions are designed to provide coordinated training and experience in data analysis, material property estimation for single- and multi-phase systems, basic process flowsheet, reactive and non-reactive mass balances, problem solving strategies and tools, and team dynamics. The course is targeted for CIT First Year students. Corequisites: 21-120, 09-105.

06-200 Sophomore Research Project
Fall and Spring
Research projects under the direction of the Chemical Engineering faculty. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the faculty supervisor. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-221 Thermodynamics
Fall: 9 units
This course introduces students to the process thermodynamics of single component systems. Topics include equilibrium and thermodynamic state variables; heat and work; conservation of energy and the first law of thermodynamics; entropy balances and the second law of thermodynamics; reversibility; free energies; retroconversion of heat and work via engines, refrigeration and power cycles; absolute temperature and the third law of thermodynamics; equations of state; principle of corresponding states; thermodynamic property relationships; changes of state; phase equilibrium and stability in single component systems; vapor pressure and phase transition. Prerequisites: 06-100 and 33-106.

06-222 Sophomore Chemical Engineering Seminar
Fall: 1 unit
This course provides an overview of the chemical engineering profession. It discusses the rationale for the curriculum, career paths, resume writing, written communication skills, and ethics, and also involves a project on the use and manufacture of chemicals.

06-261 Fluid Mechanics
Spring: 9 units
The principles of fluid mechanics as applied to engineering, including unit operations, are discussed; examples include flow in conduits, process equipment, and commercial pipes, flow around submerged objects, and flow measurement. Microscopic mass and momentum balances are described, including the continuity and Navier-Stokes equations, and modern solution techniques will be explored. Microscopic flow structures will be determined for flow visualization. Boundary layer theory, turbulence, and non-Newtonian fluids are also discussed. A case-study project based on new technological advancements is also required. Prerequisites: 06-200 and 21-259 Corequisite: 06-262.
06-262 Mathematical Methods of Chemical Engineering
Spring: 12 units
Mathematical techniques are presented as tools for modeling and solving engineering problems. Modeling of steady-state mass and energy balance problems using linear and matrix algebra, including Gaussian elimination, decomposition, and iterative techniques. Modeling of unsteady-state engineering problems using linear and nonlinear differential equations. Analytical techniques, including Laplace transforms, and numerical techniques for the solution of first- and higher-order differential equations and systems of differential equations arising in engineering models. The modeling of processes affected by chance and subject to experimental error, statistical and regression techniques within the context of experimental design and analysis of experimental data. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-300 Junior Research Project
Fall and Spring
Research projects under the direction of the Chemical Engineering faculty. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the faculty supervisor. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-321 Chemical Process Systems Design
Fall: 12 units

06-423 Unit Operations Laboratory
Fall: 9 units
Open-ended laboratory projects illustrate the principles of unit operations in Chemical Engineering. In this course students select, with course staff review, current societal problems to which chemical engineering subject knowledge can be applied. Students work in teams to design and implement an experimental plan to evaluate proposed solutions. Teams must work together to identify constraints and relationships between the unit operations they work on. Students must document implementation feasibility (cost, scheduling, analytic capability, etc.) and clearly identify the criteria and methods for assessing experimental results. Oral and written reports are required. Prerequisites: 06-361 and 06-364.

06-426 Experimental Colloid Surface Science
Fall: 9 units
Laboratory exercises will deal with preparation and stabilization of colloids, flocculation, micellar aggregates, surface tension, contact angle, spreading and adsorption. Basic concepts will be related to practical problems of wetting, lubrication, foaming, adhesion, coatings and corrosion. Prerequisites: 06-607 and 09-221.

06-462 Optimization Modeling and Algorithms
Spring: 6 units
Formulation and solution of mathematical optimization problems with and without constraints. Objective functions are based on economics or functional specifications. Both discrete and continuous variables are considered. Prerequisite: 06-421.

06-463 Chemical Product Design
Spring: 6 units
Computer-aided design of a chemical product. Course involves design of molecular structure, microstructure, or devices/processes that effect chemical change. This is a project-based course, for which an extensive report must be submitted. Prerequisite: 06-421 Corerequisite: 06-462.

06-464 Chemical Engineering Process Control
Spring: 9 units
This course presents basic concepts of process dynamics and feedback control. Included are selection of measurements and manipulated variables, definition of transfer functions, creation of block diagrams and closed loop configurations. The course also covers concepts of open loop and closed loop stability, and tuning of PID controllers.

06-466 Experimental Polymer Science
Spring: 9 units
Macromolecular behavior in bulk and in solution will be explored in experiments on tensile strength, elasticity, swelling of networks, solution viscosity, melt flow, and polymerization reactions. Particular reference will be made to aspects affecting production and fabrication of polymeric materials. Prerequisites: 09-221 and (06-609 or 09-509).

06-606 Computational Methods for Large Scale Process Design & Analysis
Spring: 9 units
This course deals with the underlying computer-aided design techniques for steady-state and dynamic simulation, numerical solution and decomposition strategies for large systems of sparse nonlinear algebraic equations, stiff ordinary differential equations, and mixed algebraic/differential systems and computer architectures for flowsheeting systems. Prerequisites: 06-262 and 06-361.

06-607 Physical Chemistry of Colloids and Surfaces
All Semesters: 9 units
Thermodynamics of surfaces; adsorption at gas, liquid, and solid interfaces; capillarity; wetting, spreading, lubrication and adhesion; properties of monolayers and thin films; preparation and characterization of colloids; colloidal stability, flocculation kinetics, micelles, electrokinetic phenomena and emulsions. Prerequisites: 06-221 and 09-347.
06-608 Safety Issues in Science and Engineering Practice  
Fall: 3 units  
Exposes the students to personal safety issues encountered in normal science and engineering practice. Topics covered include mechanical, electrical, chemical, radiation, and biological hazards, to provide an awareness of these hazards and appropriate action to be taken in the event of an accident.

06-609 Physical Chemistry of Macromolecules  
Fall: 9 units  
This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to molecular structure. Topics include an introduction to polymer science and a general discussion of commercially important polymers; molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution; solution thermodynamics and molecular conformation; rubber elasticity; and the rheological and mechanical properties of polymeric systems. Students not having the prerequisite listed may seek permission from the instructor.  
Prerequisite: 09-347.

06-610 Rheology and Structure of Complex Fluids  
Fall: 9 units  
This course will cover the basic concepts of rheology and mechanical behavior of fluid systems. Both the experimental and theoretical aspects of rheology will be discussed. The basic forces influencing complex fluid rheology and rheology will be outlined and discussed; including excluded volume, van der Waals, electrostatic and other interactions. Methods of characterizing structure will be covered including scattering techniques, optical polarimetry and microscopy. Examples will focus on several types of complex fluids including polymer solutions and melts, gelling systems, suspensions, and self-assembly fluids.  
Prerequisites: 06-609 or 09-509.

06-619 Semiconductor Processing Technology  
Spring: 9 units  
This is an introductory course to the physical and chemical concepts involved in integrated circuit processing. The material focuses on basic principles in chemical reaction engineering and how they can be applied to integrated circuit process engineering. Students not having the prerequisites listed may seek permission from the instructor.  
Prerequisites: 06-364 and 09-347.

06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods  
Spring: 9 units  
This course will explore global atmospheric chemistry through a series of case studies; Stratospheric Ozone, Global Methane and OH, and Urban and Regional Ozone. Each case will begin with a description of the chemistry and atmospheric physics fundamental to the particular problem. Students will formulate testable mathematical models incorporating that chemistry and physics, turning then to existing atmospheric data sets to test current understanding. The emphasis of this course is to develop an understanding of how to pose and test hypotheses in a complex chemical environment such as the atmosphere, validate or refute those hypotheses, and then by extension predict how the system will respond to perturbations. A particular objective is to explore how to extend this methodology from the stratosphere and background troposphere (the first two cases), where it has been applied with success, to the much more complicated problem of urban and regional air quality. Students not having the prerequisites listed may seek permission from the instructor.  
Prerequisites: 06-262 and 09-105.

06-621 Biotechnology and Environmental Processes  
Fall: 9 units  
First half of the course: microbial physiology and metabolism, fermentations and respiration, metabolic regulation, biocatalysis, recombinant DNA methodology and gene cloning. Second half: separation and purification, kinetics and design of biological reactors, mass transfer limitations within cell suspensions, and control of fermentation processes. Lectures will cover aspects of accuracy and resolution, relative merits and limitations, selection criteria, and typical practical applications for these devices. Several laboratory demonstrations will be provided. Each student will be expected to submit a project report on a topic assigned in the beginning of the course.  
Prerequisites: 03-231 or 03-232.

06-622 Bioprocess Design  
Fall and Spring: 9 units  
This course is designed to link concepts of cell culture, bioseparations, formulation and delivery together for the commercial production and use of biologically-based pharmaceuticals; products considered include proteins, nucleic acids, and fermentation-derived fine chemicals. Associated regulatory issues and biotech industry case studies are also included. A fair knowledge of cell culture and fermentation operations is assumed.  
Prerequisites: 06-621 or 42-621.

06-630 Atmospheric Chemistry, Air Pollution and Global Change  
Fall and Spring: 12 units  
Principles necessary to understand the atmospheric behavior of air pollutants in urban, regional, and global scales are the subjects of this course. Key topics include atmospheric gas-, aqueous-, and aerosol-phase chemistry; removal processes and residence times; aerosol physics; pollutant effects on visibility and the energy balance of the planet; mathematical modeling of air pollution. The student finishing the course will understand the fundamentals of atmospheric chemistry and physics and their relationship to urban, regional, and global pollution problems. Students not having the prerequisites listed may seek permission from the instructor.  
Prerequisites: 06-262 and 09-105.

06-640 Principles and Applications of Molecular Simulation  
Fall and Spring: 9 units  
This course will introduce modern concepts and methods for simulating physical and thermodynamics properties of materials from atomic-scales, with special emphasis on the gas and liquid states. Strengths and limitations of molecular simulation methods will be discussed. Topics will include basic statistical mechanics, interatomic potentials, Molecular Dynamics methods, Monte Carlo methods, computation of phase coexistence curves, and Brownian Dynamics.  
Prerequisites: 06-262 and 06-321.

06-708 Advanced Process Dynamics and Control  
Spring: 12 units  
Modeling and simulation of dynamic behavior of chemical processes. Theoretical and practical aspects of development of optimal and various regulatory control schemes for start-up and continuous process operation. Application of filtering techniques for noisy or estimated data. Process automation.  

06-714 Surfaces and Adsorption  
Spring: 3 units  
A survey of solid surfaces and gas-solid interactions. Topics include the structure and electronic properties of metal surfaces, the kinetics and thermodynamics of adsorption and desorption processes, and concepts in heterogeneous catalysis. The course emphasizes the application of recent experimental techniques in studying these problems.

06-720 Advanced Process Systems Engineering  
Spring: 12 units  
A general background on problems, methods, and tools for solving analysis and synthesis problems in process engineering. Formulation and numerical solutions of steady-state and dynamic simulation and optimization problems will be discussed. Insights and solution methods are also covered, based on both heuristics and mixed-integer programming techniques for the synthesis of heat exchanger networks, separation processes, and total process systems.

Chemistry Courses

09-101 Introduction to Experimental Chemistry  
Fall and Spring: 3 units  
This is a seven week chemistry laboratory course that is designed to introduce students to some basic laboratory skills, techniques, and equipment commonly used in experimental chemical investigations. The experiments will apply concepts in organic synthesis, quantitative analysis using visible spectrophotometry, kinetics, acid-base chemistry, thermochromy, transition metal chemistry, chromatography, and protein biochemistry. 1 hr. lecture, 3 hrs. lab.

09-102 Special Topics  
Intermittent: 3 units  
A selection of mini-courses offered to introduce first-year students to special topics in modern chemistry. The courses meet for half a semester and may include some hands-on laboratory and computer experiences. Topics vary, but have included: Forensic Chemistry in the Criminal Justice System, Macromolecules for Nanotechnology, Popularization of Science Through Books, Plays and Film, Kaboom and Other Approaches to Teaching Science, Dating Using Radioactivity and Computer Molecular Modeling. Enrollment limited to first-year MCS and SHS students.
09-103 Atoms, Molecules and Chemical Change
Fall: 9 units
This is a one-semester introductory college level course designed for non-science and engineering majors who have had a high school course in chemistry. Students with primary or additional majors in MCS, CIT or SCS will not be allowed to enroll. Chemistry topics will be introduced on an as needed basis in the contexts of air pollution, the ozone layer, global warming, acid rain, safe drinking water, alternative energy sources, pollution, and drug design. Students will apply concepts in topics such as the classification of matter, the relationship between matter and energy, atomic theory and the Periodic Table, chemical bonding, molecular shapes, molecular polarity, interparticle forces, chemical reactions, stoichiometry, properties of aqueous solutions, acid-base chemistry, redox chemistry, and organic chemistry. Students will gain an understanding of how chemistry impacts major environmental, social, political, and economic issues that we encounter daily. They will also learn to apply chemical concepts to new situations or contexts. Students with credit for 09-105 or more advanced chemistry courses will not be allowed to enroll in this course. 3 hrs. lec., 1 hr. rec.

09-104 Fundamental Aspects of Organic Chemistry and Biochemistry
Intermittent: 9 units
This course, which includes demonstrations and "hands-on" activities, is designed to engage non-majors in the fascination of chemistry. It is not essential that a student has completed 09-103 in order to take this course. The lecture part of this course will include wide ranging science topics designed to put the world of chemistry into perspective. After developing a competency in fundamentals we proceed to systematically survey the important topics of synthesis, structure and mechanism in organic chemistry. With these insights we finally confront the important biological molecules including DNA. 3 hrs lec., 1 hr rec.

09-105 Introduction to Modern Chemistry I
Fall and Spring: 10 units
This course begins with a very brief survey of some fundamental principles of chemistry and a presentation of chemically interesting applications and sophisticated problems. These will form the basis for introducing the relationships between the structure of molecules and their chemical properties and behavior. The subject matter will include principles of atomic structure, chemical bonding, intermolecular interactions and molecular structures of organic and inorganic compounds including some transition metal complexes. Relevant examples will be drawn from such areas as environmental, materials, and biological chemistry. 3 hrs. lec, 2 hrs. rec.

09-106 Modern Chemistry II
Fall and Spring: 10 units
This course provides an overview of thermodynamics, kinetics and chemical equilibrium. Topics include the flow of energy in chemical systems; the spontaneity of chemical processes, i.e. entropy and free energy; the mechanisms and rates of chemical reactions; and the use of chemical equilibrium to reason about acid-base chemistry, solubility and electrochemistry. Applications include the energy economy, biological systems and environmental chemistry. 3 hrs. lec., 2 hrs. rec.

09-107 Honors Chemistry: Fundamentals Concepts and Applications
Fall: 10 units
Honors Chemistry is an introductory course that teaches the foundations of Modern Chemistry and applies them to current scientific issues, such as Green Chemistry, Biotechnology and Materials Science. Topics include modern theories of bonding, organization of atoms, molecular interactions, biochemistry and transition metal chemistry. Enrollment is limited to first-year students, with priority given to those in MCS. 3 hrs. lec., 2 hrs. rec.

09-109 Kitchen Chemistry Sessions
Intermittent: 3 units
Ever wanted to boil water in ice? Cook an egg so the yolk is set but the white still runny? Lick a lemon or drink vinegar but have it taste “sweet”? Make “caviar” from fruit juice and noodles from yogurt? Explore the science of molecular gastronomy through the lectures and demonstrations that reveal the chemistry and biochemistry of food ingredients and their preparation. Then use a kitchen as your “laboratory” to test hypotheses and delve into molecular cooking - you may just get to eat your lab results. Students enrolling in this course are assumed to have a college level background in chemistry including introductory organic chemistry. Students without a solid chemistry background should take the lower level 09-109. 3 hrs. lec. and lab

Corequisites: 09-218, 09-220.

09-201 Undergraduate Seminar I
Fall: 1 unit
Issues and topics of importance to beginning chemistry majors are discussed in this course. It provides a general introduction to the facilities, faculty and programs of the Department of Chemistry and introduces students to career and research opportunities in the field of chemistry. Enrollment limited to students majoring in chemistry. 1 hr.

09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists
Spring: 1 unit
Issues and topics focused on laboratory safety are discussed in this class. The topics are selected to supplement information covered in 09-221, Laboratory I. This course is intended to provide the necessary safety training for students wishing to undertake undergraduate research projects in the laboratory and is taught in collaboration with the Office of Environmental Health and Safety. Enrollment is limited to chemistry majors. 1 hr.

09-204 Professional Communication Skills in Chemistry
Spring: 3 units
This required course for chemistry majors promotes development of written and oral communication skills in various formats within the discipline. Students are expected to develop these skills by becoming more familiar with the style and format of the chemical literature, current topics in chemistry, and research projects in the Department. Other learning outcomes include developing critical reading skills, providing effective feedback to peers’ written and oral communication, demonstrating the ability to revise written work, and using chemical structure drawing software. 1 hr. lec. Prerequisite: 09-221.

09-209 Kitchen Chemistry Sessions
Intermittent: 3 units
Ever wanted to boil water in ice? Cook an egg so the yolk is set but the white still runny? Lick a lemon or drink vinegar but have it taste “sweet”? Make “caviar” from fruit juice and noodles from yogurt? Explore the science of molecular gastronomy through the lectures and demonstrations that reveal the chemistry and biochemistry of food ingredients and their preparation. Then use a kitchen as your “laboratory” to test hypotheses and delve into molecular cooking - you may just get to eat your lab results. Students enrolling in this course are assumed to have a college level background in chemistry including introductory organic chemistry. Students without a solid chemistry background should take the lower level 09-109. 3 hrs. lec. and lab

Corequisites: 09-218, 09-220.

09-214 Physical Chemistry
Spring: 9 units
This is a one-semester course intended primarily for students majoring in Biological Sciences, students pursuing a B.A. degree program in Chemistry, and students in the B.S.A.program with a concentration in chemistry. The course focuses on thermodynamics, transport and reaction rates and their application to chemical and biological systems. Emphasis is given to attaining a good fundamental understanding of entropy and free energy. This is more a concepts than skills building course. Topics include applications of thermodynamics to chemical and biochemical equilibria, electrochemistry, solutions, and chemical kinetics. 3 hrs. lec. Prerequisites: 09106 and 21122 and (33111 or 31106) Prerequisites: 09-106 and 21-122 and (33-111 or 33-106).

09-217 Organic Chemistry I
Fall: 9 units
This course presents an overview of structure and bonding as it pertains to organic molecules. Selected topics include: introduction to functional group chemistry, stereochemistry, conformational analysis, reaction mechanisms and use of retrosynthetic analysis in the development of multistep syntheses. Methods for structure determination of organic compounds by modern spectroscopic techniques are introduced. 3 hrs. lec., 1 hr. rec. Prerequisites: 09-105 or 09-107.

09-218 Organic Chemistry II
Spring: 9 units
This course further develops many of the concepts introduced in Organic Chemistry I, 09-217. Emphasis is placed on the utilization of reaction mechanisms for understanding the outcome of chemical transformations, and the employment of a wide variety of functional groups and reaction types in the synthesis of organic molecules. Also included in the course will be special topics selected from the following: polymers and advanced materials, biomolecules, nucleic acids, and drug design. 3 hrs. lec., 1 hr. rec. Prerequisites: 09-217 or 09-219.
09-219 Modern Organic Chemistry  
Fall: 10 units  
Traditional introductory organic chemistry courses present structure, reactivity, mechanisms and synthesis of organic compounds. Students taking 09-219 will be exposed to the same topics, but presented in greater depth and broader context, with applications to allied fields such as (1) polymer and materials science, (2) environmental science and (3) biological sciences and medicine. This will be accomplished through an extra 50 minute lecture period, where more advanced topics and applications will be discussed. Topics will include computational chemistry, green chemistry, chiral separations, photochemistry, reaction kinetics, controlled radical polymerizations and petroleum cracking. Students who complete 09-219 will have a strong foundation in organic chemistry as well as a sophisticated understanding of how organic chemistry is currently practiced. 4 hrs. lec., 1 hr. rec.  
Prerequisites: 09-105 or 09-107.

09-220 Modern Organic Chemistry II  
Spring: 10 units  
This course builds on 09-219 by introducing students to additional functional groups, chemical reaction mechanisms and synthetic strategies commonly used in the practice of organic chemistry. Advanced topics to be presented during the extra lecture will include multidimensional NMR spectroscopy, enantioselective synthesis, ionic polymerization, biorganic and medicinal chemistry, natural products chemistry and toxicology. Students who complete 09-220 will have a strong foundation in synthetic, mechanistic and structural organic chemistry and will understand how this applies to human health and the environment. 4 hrs. lec., 1 hr. rec.  
Prerequisite: 09-219.

09-221 Laboratory I: Introduction to Chemical Analysis  
Fall and Spring: 12 units  
This course is the first in a sequence of four laboratory courses on experimental aspects of chemistry required for the B.S. degree in chemistry. The experimental work emphasizes the techniques of quantitative chemical analysis. Included are projects dealing with a variety of instrumnetal and wet chemical techniques. The course is project-oriented with the experiments becoming more complex, requiring greater student input into the experimental design as the semester progresses. A mixture of individual and team experiments are conducted during the semester. In addition to techniques, safety, written and oral communication skills, and effective teamwork are emphasized. 2 hrs. lec., 6 hrs. lab.  
Prerequisite: 09-219.

09-222 Laboratory II: Organic Synthesis and Analysis  
Fall and Spring: 12 units  
In this second course in the laboratory sequence, students acquire laboratory skills relevant to synthesis and purification of organic compounds, as well as the practical use of chromatography and spectroscopy. Students will also further develop technical writing skills through preparation of lab reports. 2 hrs. lec., 6 hrs. lab.  
Prerequisites: (09-217 or 09-219) and 09-221  
Corequisites: 09-220, 09-218.

09-231 Mathematical Methods for Chemists  
Fall: 9 units  
This course covers mathematical techniques that are important in the chemical sciences. The techniques will be covered in the context of chemical phenomena, and combine topics from 3-dimensional calculus, differential equations, linear algebra and statistics. This course does not count towards the minor in chemistry. 3 hrs. lec.  
Prerequisites: (09-106) and (21-122 or 21-124).

09-301 Undergraduate Seminar III  
Fall: 1 unit  
Students attend seminars on current topics in chemistry. Students are sent a menu of choices for each week of the semester and may select topics of interest. Enrollment is restricted to students majoring in chemistry. 1 hr.  
Prerequisites: 09-105 or 09-107 and (33-106 or 33-111)  
Corequisite: 09-231.

09-302 Undergraduate Seminar IV  
Spring: 1 unit  
Students attend seminars presented by senior chemistry majors. Students provide peer evaluations of the seminars and through the process students become familiar with special topics in chemistry. The course establishes what should be included in a good seminar. This seminar courses is one of 6 required for the chemistry major. If a schedule conflict exists, students may, with permission of the instructor, attend other chemistry seminars or make other arrangements to fulfill the requirement. 1 hr.  
Prerequisites: 09-106 and (21-259 or 09-231).

09-321 Laboratory III: Molecular Design and Synthesis  
Fall: 12 units  
In this third course in the laboratory sequence, students will learn a variety of more advanced techniques for organic synthesis and characterization, and will gain experience with developing and designing synthetic procedures. Student writing skills are further reinforced through preparation of detailed lab reports. 2 hrs. lec., 6 hrs. lab.  
Prerequisites: (09-218 or 09-220) and 09-222.

09-322 Laboratory IV: Molecular Spectroscopy and Dynamics  
Spring: 12 units  
This laboratory course is devoted to physical chemistry experiments, which involve the use of modern spectroscopic instrumentation to probe the optical and magnetic properties of molecules. The experiments include the use of high-resolution infrared, laser Raman, NMR, EPR, fluorescence, and UV-visible spectroscopies. Additional experiments demonstrate methods for measuring enzyme-catalyzed reaction rate constants, and the use of scanning probe microscopy for imaging and characterization of biological macromolecules. Throughout the course the students will learn how to use computer algebra packages for rigorous data analysis and modeling and will develop the skills in basic electronics, and vacuum techniques. 2 hrs. lec., 6 hrs. lab.  
Prerequisites: 09-221 and 09-331 and 09-344  
Corequisite: 09-345.

09-323 Bioorganic Chemistry Laboratory  
12 units  
Bioorganic chemistry is concerned with the action of synthesized compounds on biological systems. In order to maximize the likelihood of identifying a biologically active compound, synthetic libraries are often employed, requiring extensive familiarity with simple, efficient chemical coupling steps and protecting group chemistry. In this inquiry based laboratory course, using a process that mimics the current practice in drug discovery by pharmaceutical companies, students will rationally design a compound library in hopes of finding a compound active against a selected biological target, search for active compounds in the library, and then quantitatively characterize any identified compounds for activity. Working in small groups, students will develop proposals for and execute the target assay selected, the library synthesis, and the screening approach. Students will write reports summarizing the results in each phase of the course. Throughout the course, students will be introduced to concepts relevant to industrial scientific research, including regulatory compliance, quality control and assurance, and intellectual property.  
Prerequisites: 09-222 and 09-220.

09-331 Modern Analytical Instrumentation  
Fall: 9 units  
This course will cover all aspects of analytical instrumentation and its application to problems in materials, environmental, and biological chemistry. Topics covered will include mass spectrometry, optical spectroscopies and NMR. In addition, the course will emphasize how to select an analytical method appropriate to the problem at hand, how to optimize the signal to noise obtained by a measurement, and the quantitative analysis of experimental data. Some basic electronics will be covered as well. 3 hrs. lec.  
Prerequisites: 09-221 and 09-222  
Corequisite: 09-344.

09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry  
Fall: 9 units  
The measurement and theoretical description of the properties of atoms and molecules are presented. The elementary principles of quantum chemistry are developed. The many types of spectroscopy used to study atoms and molecules are described. Methods of atomic structure determination are discussed. The structure and properties of solids are also presented. The basic results of statistical chemistry are outlined and a brief connection to thermodynamics is made. 3 hrs. lec., 1 hr. rec.  
Prerequisites: (09-105 or 09-107) and (33-106 or 33-111)  
Corequisite: 09-231.

09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry  
Spring: 9 units  
The measurement and theoretical descriptions of the equilibrium properties of chemical systems are presented. Chemical thermodynamics is introduced at the upper division level. The phases of matter are discussed. The quantitative treatment of mixtures is developed. The detailed description of chemical equilibrium is elaborated. The measurement and theoretical description of the nonequilibrium properties of chemical systems are presented. Elementary transport properties are introduced. The principles of classical chemical kinetics are developed in great detail. 3 hrs. lec., 1 hr. rec.  
Prerequisites: 09-106 and (21-259 or 09-231).
Maximum number of units taken per semester is 18.

The number of units taken generally corresponds to the actual number of hours the student actually spends in the lab doing research during the week. The focus of this class is understanding the properties of the elements and the periodic table. 3 hrs. lec., 1 hr. rec.

The course allows students to earn academic credit for concentrated study in a topic area developed in conjunction with and monitored by a faculty advisor in chemistry majors. No exceptions possible. Enrollment is limited to students majoring in chemistry. 1 hr.

All Semesters

The course allows students to earn academic credit for concentrated study in a topic area developed in conjunction with and monitored by a faculty member in the Department of Chemistry. These topics are distinct from projects that would rise to the level of undergraduate research either because they are in unrelated areas distinct from the faculty member's research interests or may constitute the investigation and compilation of existing information from a variety of resources and may not be expected to result in the generation of new information as is a reasonable expected outcome in undergraduate research (likely is not publishable).

Fall and Spring

Students enrolled in the departmental honors program (B.S. with Departmental Honors or combined 4-year B.S./M.S. degree) are required to enroll in this course to complete the honors degree requirements. A thesis written in an acceptable style describing an original research project, and a successful oral defense of the thesis topic before a Thesis Committee are required. Limited to students accepted into the honors program. (B.S. Honors candidates normally enroll for 6 units; B.S./M.S. candidates enroll for 15 units.).

A study of the synthesis and reactions of high polymers. Emphasis is on practical polymer preparation and on the fundamental kinetics and mechanisms of polymerization reactions. Topics include: relationship of synthesis and structure, step-growth polymerization, chain-growth polymerization via radical, ionic and coordination intermediates, copolymerization, discussions of specialty polymers and reactions of polymers. 3-6 hrs. lec. (Graduate Course: 12 units, 09-741)

Prerequisites: 09-218 or 09-220.

This course discusses the chemistry, physics, and biology aspects of several major types of nanoparticles, including metal, semiconductor, magnetic, carbon, and polymer nanostructures. For each type of nanoparticles, we select pedagogical examples (e.g. Au, Ag, CdSe, etc.) and introduce their synthetic methods, physical and chemical properties, self assembly, and various applications. Apart from the nanoparticle materials, other topics to be briefly covered include microscopy and spectroscopy techniques for nanoparticle characterization, and nanolithography techniques for fabricating nano-arrays. The course is primarily descriptive with a focus on understanding major concepts (such as plasmon, exciton, polaron, etc.). The lectures are power point presentation style with sufficient graphical materials to aid students to better understand the course materials. Overall, this course is intended to provide an introduction to the new frontiers of nanoscience and nanotechnology. Students will gain an understanding of the important concepts and research themes of nanoscience and nanotechnology, and develop their abilities to pursue highly disciplinary nanoscience research. The course should be of interest and accessible to advanced undergraduates and graduate students in fields of chemistry, materials science, and biology. 3 hrs. lec.

Enrollment is restricted to students majoring in chemistry. 1 hr.

This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to chain microstructure. Topics include an introduction to polymer science and a general discussion of commercially important polymers; molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution; solution thermodynamics and molecular conformation; rubber elasticity; and the rheological and mechanical properties of polymeric systems. (This course is also listed as 06-609. Graduate Course: 12 units, 09-715) 3 hrs. lec.

Students enrolled in the course present a 20 - 30 minute oral report on a current topic in chemistry. This may be from the student’s research work or a special chemistry topic of general interest. Presentations or papers prepared for other courses are not acceptable for this purpose. Other students in the class submit written evaluations of the presentation. Talks are recorded for viewing by the student and instructor as a means of providing individualized feedback about presentation skills. A seminar presentation is required of all chemistry majors. No exceptions possible. Enrollment is limited to students majoring in chemistry. 1 hr.

This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to chain microstructure. Topics include an introduction to polymer science and a general discussion of commercially important polymers; molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution; solution thermodynamics and molecular conformation; rubber elasticity; and the rheological and mechanical properties of polymeric systems. (This course is also listed as 06-609. Graduate Course: 12 units, 09-715) 3 hrs. lec.

Students enrolled in the course present a 20 - 30 minute oral report on a current topic in chemistry. This may be from the student’s research work or a special chemistry topic of general interest. Presentations or papers prepared for other courses are not acceptable for this purpose. Other students in the class submit written evaluations of the presentation. Talks are recorded for viewing by the student and instructor as a means of providing individualized feedback about presentation skills. A seminar presentation is required of all chemistry majors. No exceptions possible. Enrollment is limited to students majoring in chemistry. 1 hr.
09-510 Introduction to Green Chemistry
Spring: 9 units
Students will learn about green chemistry as the design of chemical products and processes that reduce and eliminate the use and generation of hazardous substances. The key role that sustainability ethics can play in redirecting the chemical enterprise toward sustainable technologies will be highlighted. With elemental toxicants such as lead, the industrial history (including the ancient history), chemical properties, mechanistic toxicity, and progress with reduction and elimination will be analyzed to develop understanding on the criticality of avoiding the like in the future. Particular attention will also be paid to persistent, bioaccumulative, molecular toxicants that are responsible for major adverse effects on human health and the environment—the material will cover the developmental history, uses and perceived benefits, mechanisms of toxicity, and extraordinary cultural struggles that have accompanied attempts to balance economic pluses against health and environmental negatives. The findings of environmental health scientists relating to low dose adverse effects of certain everyday chemicals will be examined. This will include an analysis of non-monotonic dose-response behaviors that have their roots in the disruption of the endocrine system’s control over cellular development. A significant effort has been made by the instructor to produce a course that is suitable for students from multiple disciplines. The overarching goal is to develop critical thinking on sustainability related technical topics. Graded materials are associated mostly with essay assignments based on student analyses of books in sustainability ethics, low-dose toxicity discoveries, and industrial history that reveals the underlying dynamics of the chemical enterprise that are either pluses or minuses for sustainability. This course is recommended for students in the junior and senior year. (Graduate course 12 units 09-710) 3 hrs. lec.
Prerequisites: (09-218 or 09-220) and 09-348.

09-517 Organotransition Metal Chemistry
Intermittent: 9 units
The first half of this course focuses on the fundamentals of structure and bonding in organotransition metal complexes and how the results can be used to explain, and predict, chemical reactivity. The latter half of the course covers applications, and more specifically, homogeneous catalysts for industrial processes and organic synthesis. (Graduate Course: 12 units, 09-717)
Prerequisite: 09-348.

09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates
Fall: 9 units
This course will introduce students to new developments in chemistry and biology, with emphasis on the synthesis, structural and functional aspects of nucleic acids and carbohydrates, and their applications in chemistry, biology and medicine. Later in the course, students will have the opportunity to explore cutting-edge research in this exciting new field that bridges chemistry with biology. Students will be required to keep abreast of the current literature. In addition to standard homework assignments and examinations, students will have the opportunity to work in teams to tackle contemporary problems at the forefront of the field. The difference between the 09-518 (9-unit) and 09-718 (12-unit) is that the latter is a graduate level course. Students signed up for 09-718 will be required to turn in an original research proposal at the end of the course, in addition to all the other assignments. (Graduate Course: 12 units, 09-718) 3 hrs. lec.
Prerequisites: 09-218 or 09-220.

09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
Spring: 9 units
This course will introduce students to new developments in chemistry and biology, with emphasis on the synthesis, structural and functional aspects of peptides, proteins and small molecules. Basic concepts of bioorganic chemistry will be presented in the context of the current literature and students will have the opportunity to learn about the experimental methods used in various research labs. An introduction to combinatorial chemistry in the context of drug design and drug discovery will also be presented. Students will be required to keep abreast of the current literature. Homeworks and team projects will be assigned on a regular basis. The homework assignments will require data interpretation and experimental design; and team projects will give students the opportunity to work in teams to tackle contemporary problems at the interface of chemistry and biology. Students enrolled in the graduate level course (09-719) will be required to turn in an original research proposal at the end of the course, in addition to the homework assignments, midterm, and final exam that are required for the undergraduate course. (Graduate Course: 12 units 09-719) 3 hrs. lec.
Prerequisites: 09-218 or 09-220.

09-520 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods
Intermittent: 9 units
This course will explore global atmospheric chemistry through a series of case studies: Stratospheric Ozone, Global Methane and OH, and Urban and Regional Ozone. Each case will begin with a description of the chemistry and atmospheric physics fundamental to the particular problem. Students will formulate testable mathematical models incorporating that chemistry and physics, turning them to existing atmospheric data sets to test current understanding. The emphasis of this course is to develop an understanding of how to pose a testable hypotheses in a complex chemical environment such as the atmosphere, validate or refute those hypotheses, and then by extension predict how the environment—will the material will cover the developmental history, uses and perceived benefits, mechanisms of toxicity, and extraordinary cultural struggles that have accompanied attempts to balance economic pluses against health and environmental negatives. The findings of environmental health scientists relating to low dose adverse effects of certain everyday chemicals will be examined. This will include an analysis of non-monotonic dose-response behaviors that have their roots in the disruption of the endocrine system’s control over cellular development. A significant effort has been made by the instructor to produce a course that is suitable for students from multiple disciplines. The overarching goal is to develop critical thinking on sustainability related technical topics. Graded materials are associated mostly with essay assignments based on student analyses of books in sustainability ethics, low-dose toxicity discoveries, and industrial history that reveals the underlying dynamics of the chemical enterprise that are either pluses or minuses for sustainability. This course is recommended for students in the junior and senior year. (Graduate course 12 units 09-710) 3 hrs. lec.
Prerequisites: (09-218 or 09-220) and 09-348.

09-521 Bioinorganic Chemistry
Intermittent: 9 units
This course addresses the basis for the selection and regulation of metal atoms and ligand systems and their interactions with their corresponding protein environments. The chemistry of catalytic processes in metalloenzymes, and atom transfer and electron transport in metalloproteins will be reviewed. The array of physical methods required for study will be introduced, with application toward the determination of electronic and molecule structure and enzymatic mechanisms. (Graduate Course: 12 units, 09-721) 3 hrs. lec.
Prerequisites: 09-344 and 09-348.

09-522 Oxidation and Inorganic Chemistry
Intermittent: 9 units
The roles of metal complexes in chemical and biochemical oxidations will be presented. Special attention is given to processes involving the activation of molecular oxygen and hydrogen peroxide by metal complexes and metalloenzymes from a mechanistic viewpoint. Much attention is devoted to kinetic methods of investigation of homogeneous reactions and mechanisms of oxidative catalysis. For this reason, a mini course on mechanisms of chemical reactions in solution is integrated. Redox properties and electronic structures of metal complexes will be reviewed. The relationships between electronic structures, catalytic properties, and oxidation reactivity of biologically relevant metal complexes will be provided. Mechanistic pathways of oxidation by peroxidases, cytochrome P-450, and other metalloenzymes will be described. (Graduate course 09-722, 12-units) 3 hrs. lec.
Prerequisite: 09-348.

09-525 Transition Metal Chemistry
Intermittent: 9 units
This course covers fundamental concepts in Transition Metal Chemistry, including coordination numbers and stereochemistry, electronic structure, physical properties, and aspects of chemical reactivity of transition elements and their complexes. Point group theory is used to link the geometric and electronic structures of high symmetry coordination compounds. Analysis of the electronic structure of low symmetry coordination complexes is based on the Angular Overlap Model. In choosing coordination complexes that are discussed in class, special emphasis is given to those that are relevant for the fields of research of students enrolled in the class, such as supramolecular chemistry, nanotechnology, and metal-based catalysis. Students learn about the choice and relevance of modern questions posed by researchers in these fields and the modern methods and techniques used to answer the questions. Students learn also in this course how to use the Cambridge Crystallographic Database, a repository of structural data for more than 200,000 compounds, and how to use Mathematica to solve chemical problems. No prior knowledge of this software is required. (Graduate Course: 12 units, 09-725) 3 hrs. lec.
Prerequisite: 09-348.

09-531 Polymer Science
Fall: 9 units
Polymer science is a vibrant multidisciplinary activity. It uses the methods of chemistry, physics, chemical engineering, materials science and biology to create a coherent picture of the macromolecular world. This course is a survey of this field of knowledge suitable for senior chemistry majors or other students with a desire for a broad knowledge of the science and engineering of polymers. It covers a thorough description of the field, the synthetic chemistry of macromolecules, the physical chemistry of macromolecules, and the principles of polymer processing. Prerequisites: (09-217 or 09-219) and (09-345 or 09-347 or 09-214).
09-534 Chemical Approaches to Energy Conversion & Storage
Spring: 9 units
Solar energy and electrical energy from renewable resources need to be stored to resolve intermittency issues. Energy can be stored through charge transfer, changes in chemical bonding, or in electric polarization. This course will introduce students to general aspects of energy-storage technologies using these strategies, integrating scientific and engineering perspectives to discuss thermodynamics, mechanisms of energy storage, and fundamental aspects of efficiency, capacity, and power delivery. Then we will explore current and experimental technologies, covering supercapacitors, batteries, and water-splitting catalysts. By the end of the course, students will be able to apply chemical principles to understand energy-storage technologies and gain knowledge of important classes of these systems. Students enrolled in 09-734 (rather than 09-534) will also be required to write a 15-page NSF style proposal. 3 hrs. lec. Prerequisites: (09-217 or 09-219) and (09-345 or 09-347 or 27-215 or 33-341 or 24-324).

09-535 Applied topics in Macromolecular and Biophysical Techniques
Fall: 9 units
Applications of physical chemistry are widespread. Physical chemical principles are fundamental to the methods used to sequence human genome, obtain high resolution structures of proteins and complex nucleic acids e.g., ribosome, and further provides the framework to predict how molecules fold in 3-dimension, how the different domains interact (inter- and intra-molecular interactions) to perform biological functions. The principles that were discussed in theory in undergraduate physical chemistry classes, will be applied in order to understand the molecular structures and dynamics in nucleic acids and proteins, and to more advanced molecular motors. In the last decade major advances have been made through single-molecule studies that provide finer details of macromolecules in action. This course aims to teach and apply physical chemistry as related to biological problems. Prerequisites: (09-214 or 09-345 or 09-347) and (03-121 or 03-231 or 03-232).

09-543 Mass Spectrometry: Fundamentals, Instrumentation and Techniques
Intermittent: 6 units
The course is intended for students interested in understanding fundamentals, instrumentation and techniques used in mass spectrometry (MS). The operating principles of various ion sources (EI, CI, PI, ESI, LD1 and MALDI), mass analyzers (magnetic, quadrupole, time-of-flight (TOF), ion traps and Fourier transform) and detectors are covered. Applications are focused in the areas of small molecule, proteomics and polymer characterization. Sample preparation, protein identification, peptide sequencing, polymer polydispersity analysis and molecular mass are covered. Advanced techniques such as GC/MS, LC/MS, and LC/TOF MS are covered as well as hybrid mass analyzers (e.g., linear ion trap/orbitalrap). Various MS scan modes (i.e., SIM, SRM, MS/MS) and basic spectrum interpretation are covered. Students are exposed to QET and RBKM theory and select gas phase reactions. The lecture is supplemented with the use of the "Virtual Mass Spectrometry Laboratory" Internet tool, remote control of mass spectrometers and laboratory. A basic understanding of introductory physics and organic chemistry is expected. 3 hrs. lec., 1.5 hrs. lab. Prerequisites: 09-214 or 09-345 or 33-341.

09-560 Computational Chemistry
Fall: 12 units
Computer modeling is playing an increasingly important role in chemical, biological and materials research. This course provides an overview of computational chemistry techniques including molecular mechanics, molecular dynamics, electronic structure theory and continuum medium approaches. Sufficient theoretical background is provided for students to understand the uses and limitations of each technique. An integral part of the course is hands on experience with state-of-the-art computational chemistry tools running on graphics workstations. 3 hrs. lec. Prerequisites: 15-110 and 09-344 and 09-345.

09-604 Introduction to Chemical Kinetics
Spring: 6 units

09-611 Chemical Thermodynamics
Fall: 6 units
A focused course on chemical thermodynamics. The basic thermodynamic functions will be introduced and discussed. The formal basis for thermochromics will be presented. Single component phase equilibrium will be considered. The thermodynamic basis of solutions will be developed and applied to separation methods. The fundamental basis of chemical equilibrium will be developed and applied to a wide variety of reactions. Finally, a few special topics such as self-assembled systems will be presented. This is a graduate level course in chemistry and assumes the appropriate undergraduate preparation. Prerequisites: 09-231 and 09-345.

09-612 Introduction to Quantum Chemistry
Spring: 6 units
This course provides an introduction to quantum principles. The main topics to be covered include the Schroedinger equation, particle in a box, the harmonic oscillator, and the rigid rotor. Applications to vibrational, electronic, and NMR spectroscopy are discussed. Topics in perturbation theory and time-dependent quantum theory are introduced as well.

09-614 Spectroscopy
Intermittent: 6 units
This is a course exclusively in optical methods, both time resolved and steady state. In addition to methodology, spectral interpretation in terms of group theory will be discussed. The time-dependent formalism of quantum mechanics will also be introduced. Molecules in gas phase and condensed phase will be discussed. Frequent use will be made of the current literature. Background consisting of undergraduate physical chemistry is assumed. This course has a prerequisite 09-344, Quantum Chemistry or permission of the instructor.

09-701 Quantum Chemistry I
Fall: 12 units
The main topics to be covered will include exploration of the Schroedinger equation, operators, particle in the box, harmonic oscillator and hydrogen atom, tunneling, Stern-Gerlach experiment and quantum mechanical postulates, time-independent and time-dependent perturbation theory, matrix diagonalization. The student will learn to master the fundamental concepts and techniques of quantum mechanics. The parallel mini course Mathematical Analysis for Chemistry will provide the necessary mathematical background.

09-702 Statistical Mechanics and Dynamics
Intermittent: 12 units
This course will address the application of statistical mechanics to chemical systems. Topics to be discussed include the calculation of thermodynamic functions, phase transitions and chemical equilibrium, calculation of the transport properties of gases and liquids and the elementary theory of chemical kinetics. Prerequisites: 09-611 and 09-701.

09-705 Chemosensors and Biosensors
Intermittent: 12 units
Chemosensors and biosensors rely on "recognition" and "signaling" elements to transduce a molecular-scale binding event into an observable signal. Students in this course will be introduced to current research and technology for detecting chemical and biological analytes in a variety of contexts, including environmental testing, biological probing and medical diagnostics. Recognition elements ranging from small organic molecules to antibodies will be presented, while various detection modes, including fluorescence, gravimetric and colorimetric, that illustrate different signaling technologies will be presented, while various detection modes, including fluorescence, gravimetric and colorimetric, that illustrate different signaling elements will be discussed and compared. Issues to be addressed include sensitivity, selectivity and efficiency. Each sensor will be analyzed in terms of the physical chemistry, organic chemistry and/or biochemistry underlying its function. This is a graduate level course that may also be appropriate for upper level undergraduates in chemistry and the biological sciences. The material in 09-519 or 09-719 would be appropriate background material for this course. 3 hrs. lec.

09-711 Physical Organic Chemistry
Fall: 12 units
This course introduces students to the study of structure and reactivity of organic compounds from a physical and theoretical standpoint. Students will learn the fundamentals of molecular orbital theory along with some practical applications to aromaticity and anti-aromaticity. Methods are described for the study of reaction mechanisms by means of physical methods such as kinetics, isotope effects, substituent effects, and solvent effects. Important reactive intermediates are described, along with detection methods. This course may be suitable for upper level undergraduates in chemistry with the appropriate background in organic chemistry and physical chemistry. 3 hrs. lec.

Prerequisites: 09-220 and 09-345.
09-714 Advanced Organic Chemistry
Spring: 12 units
This course will expose the students to modern methods of organic synthesis including insights into the basis and mechanisms of chemical reactions. Topics include but are not limited to: modern spectroscopic analysis and structure determination, synthetic methods, retrosynthesis, organic reaction mechanisms, and references to separation techniques and some analytical methods. Upon completion of the course students should be able to design reaction schemes using scientific literature sources, evaluate their suitability for use in the lab and develop an aptitude in identifying the use of modern reagents that are more efficient, specific, safer and environmentally friendly. It is assumed that at minimum students will have completed at least two semesters of undergraduate coursework in organic chemistry and suggested that they have completed 09-222 and 09-321, the organic laboratory courses. 3 hrs. lec.
Prerequisites: 09-219 or 09-220.

09-716 Bioactive Natural Products
Spring: 6 units
This mini-course is aimed at students with an interest in natural products research. Natural products are used as active components in medicinal products, as model compounds for further development into medicinally active drugs, as ingredients in food and for flavor and fragrances, among other very useful and interesting applications. An overview of the structural variety and activity of natural products will be presented along with their isolation and structural determination. Overall, the course will offer an introduction to the work that is customary in natural product research. This course will cover: Strategies to select the plant or marine material for study; main groups of natural products derived from plants; representative natural products derived from marine organisms; preparation of extracts and selection of active fractions, screening strategies; separation and purification of active components; bench-top bioassays and chemical-assays and structure elucidation (especially 2D-NMR spectroscopy) Student’s performance will be assessed by weekly assignments on the topics discussed in lecture and by two exams. 3 hrs. lec.
Prerequisites: (09-218 or 09-220) and (09-222).

09-720 Physical Inorganic Chemistry
Intermediate: 12 units
This course develops the principles of magnetocchemistry and inorganic spectroscopy. Electronic absorption, magnetic circular dichroism, resonance raman, NMR, EPR, Mossbauer, magnetization and x-ray methods will be introduced with application towards the determination of electronic structures of transition metal complexes. Prerequisites: 09-344 and 09-345 and 09-348.

Intermediate: 12 units
Proximal probe techniques are revolutionizing physical and biological sciences, owing to their ability to explore and manipulate matter at the nanoscale, and to operate in various environments (including liquids). Proximal probe techniques rely on the use of nanoscale probes, positioned and scanned in the immediate vicinity of the material surface. Their development is often viewed as a first step towards nanotechnology, since they demonstrate the feasibility of building purposeful structures one atom or one (macro)molecule at a time. This course is designed for the students of chemistry, biology physics and engineering, who are interested in the fundamentals of proximal probe techniques and in their applications in various areas, converging into a rapidly developing, interdisciplinary field of nanoscience. It will provide physical background of such basic techniques as Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and Near-Field Scanning Optical Microscopy (NSOM) and of their variants. Throughout the course, the working "virtual AFM" computer model will be assembled in classroom by each student and then used extensively to gain thorough understanding of AFM operation principles. Particular emphasis will be placed on modes of operation facilitating chemical contrast and contrast based on other material properties. (No prior experience with computer programming required). 3 hrs. lec.

09-803 Chemistry of Gene Expression
Intermittent: 12 units
This course examines the chemical basis of biological reactions required for the propagation of genetic information stored in DNA and the organic chemistry principles behind the structure and function of nucleic acids. Main topics of lectures and class discussion will include the chemical and biochemical syntheses, properties and analyses of natural and modified nucleic acids to investigate cellular processes such as transcription, RNA splicing, other RNA regulation and translation, an introduction to the enzymatic strategies that accelerate these chemical reactions and a comparison of protein enzymes, ribozymes and other nucleic acid based enzymes in contemporary chemistry and biology. Students will learn to critically evaluate current scientific efforts that examine various aspects of chemistry and biological chemistry, the relationship between the structure and function of biomolecular systems, propose experiments to examine biological chemistry research problems and communicate these ideas and participate in scientific discussions and debates. 3 hrs. lec.
Prerequisites: 09-518 or 09-718 or (03-442 and 09-218).

09-841 Spectroscopy
Intermittent: 12 units
This course emphasizes the use of modern optical methods in the study of molecular properties and reactivity. Basic topics such as the use of group theory in the analysis of vibrational and electronic spectra are covered in detail. In addition, recently developed techniques such as time-resolved and nonlinear spectroscopies are discussed as are applications of optical methods to problems in chemistry, biology and materials science. This course might be appropriate for upper level undergraduate students in chemistry who have the appropriate background in instrumental analysis and physical chemistry. Prerequisites: 09-344 and 09-345.

Civil Environmental Engineering Courses

12-100 Introduction to Civil and Environmental Engineering
Fall and Spring: 12 units
Introduction to selected subfields in the discipline, such as structural engineering, construction project management, and environmental engineering. Problem-solving exercises apply fundamental concepts from these subfields to integrate the steps of analysis, synthesis, and evaluation through individual homework assignments and group projects that require attention to a broad range of issues. The course also exposes the students to issues related to engineering practice such as working in teams, scheduling, evaluating risk and making ethical decisions. In addition to regular lectures and project exercises, the course includes guest speakers and class demonstrations. 3 hrs., rec., 1 hr. lab.
Corequisites: 21-120, 33-106.

12-201 Geology
Spring: 9 units
Introduction to physical geology; common rocks and rock-forming minerals and their chemical compositions/structure, physical properties, origins, and uses; geologic processes: surface and ground-water flow, volcanism, mountain-building, tectonics, glaciation, sedimentation, seismicity, and atmospheric and oceanic circulation.

12-212 Statics
Fall: 9 units
Introduction to vector mechanics; equivalent systems of forces; equilibrium of rigid bodies; free body diagram; distributed forces, hydrostatic forces, effective forces, centroids; applications to simple statically determinate trusses, beams, frames, cables and other physical systems; friction.

12-231 Solid Mechanics
Spring: 9 units
Analysis of deformable bodies incorporating concepts of stress, strain, mechanical properties of materials, and geometric compatibility. Response under axial loads, torsion, bending, transverse shear, and combined loadings. Stress and strain transformations and Mohr’s circles, deflections of beams and shafts, buckling of columns.
Prerequisite: 12-212
Corequisite: 21-259.

12-232 Solid Mechanics Lab
Spring: 3 units
Analysis of stress-strain relationships, torsion of solid shafts, deformation due to bending, deformations in three dimensions, Mohr’s circle representation of stress and strain, buckling of slender columns. Laboratory experiments and reports associated with theoretical concepts.
Prerequisite: 12-212
Corequisite: 12-231.
12-271 Introduction to Computer Application in Civil & Environmental Engineering
Spring: 9 units
Introduction to the use of computer-based applications in civil engineering, using generic tools such as spreadsheets, equation solvers and computer graphics. Discussion of the role of computer-based methods in civil engineering practice.
Prerequisites: 21-120 and 33-106.

12-301 Civil Environmental Engineering Projects
Fall: 9 units
Basic elements of civil and environmental engineering projects, from project conception through design, to implementation and operation. Project components are explored through formal instruction combined with analysis of actual engineering projects and student team activities. The role of project management and relevant business concepts are also discussed. The course is intended to develop skills and understanding related to the application of engineering and science principles, approximations, empiricism, and experience to engineering projects and public policy issues related to projects; basic theory and practice of design; the importance and challenge of team efforts; leadership, individual and group ethical behavior and effective communication; and the utility of measurements, modeling, visualization, quality control, and engineering graphics.
Prerequisites: 12-212 and 12-271.

12-335 Soil Mechanics
Fall: 9 units
Sampling, testing and identification of soils. Physical, chemical and hydraulic characteristics. Stress-strain-strength relationships for soils. Permeability, seepage, consolidation, and shear strength, with applications to deformation and stability problems, including earth dams, foundations, retaining walls, slopes and landfills. Prerequisites: 12-231 and 33-107: Corequisite: 12-355
Prerequisite: 12-231
Corequisite: 12-335.

12-336 Soil Mechanics Laboratory
Fall: 3 units
Examination of material properties and behavior of soils. Experiments include soil classification, permeability, compaction, consolidation and strength tests.
Prerequisite: 12-231
Corequisite: 12-335.

12-351 Environmental Engineering
Spring: 9 units
Provides a scientific and engineering basis for understanding environmental issues and problems. Introduces material and energy balances for tracking stocks and flows in the atmosphere, source and ground waters, and soil systems. Pertinent environmental laws are described, simple quantitative engineering models are developed, and qualitative descriptions of environmental engineering control technologies are presented. Prerequisites: 09-105, 21-260 and 12-355
Prerequisites: 09-105 and 21-260.

12-352 Environmental Engineering Lab
Spring: 3 units
(Required for CEE students, not for others) Laboratory and field experiments that illustrate the basic principles of environmental engineering.
Corequisite: 12-351.

12-355 Fluid Mechanics
Fall: 9 units
Fluid characteristics; continuity, momentum and energy equations; dynamic similitude; laminar and turbulent boundary layers; flow in pipes; lift and drag on immersed bodies; open channel flow. Prerequisites: 21-260 and 21-259

12-356 Fluid Mechanics Lab
Fall: 3 units
Fluid properties: density, specific gravity, viscosity; fluid characteristics; continuity, conservation of energy; fluid behavior: center of pressure, pipe flow, open-channel flow. Laboratory experiments illustrating basic principles.
Corequisite: 12-355.

12-358 Materials Lab
Spring: 3 units
Examination of materials properties and behavior of concrete, masonry, and timber.
Prerequisite: 27-357.

12-401 Civil & Environmental Engineering Design
Fall: 15 units
Methodology for formulating and solving design problems, characterized by incomplete specifications, open-ended solution space, and partial evaluations. The methodology is illustrated and applied in the context of realistic design problems drawn from civil and environmental engineering. Design projects performed by teams, emphasizing collaborative problem-solving and preparation of written and oral reports. The importance of ethics, life long learning, and professional licensure are also discussed.
Senior Standing in Civil and Environmental Engineering or instructor approval for Design Minors. Corequisite: 12-301.

12-411 Project Management for Construction
Fall: 9 units
Introduction to construction project management from owner’s perspective in organizing planning, design, construction and operation as an integrated process. Examination of labor productivity, material management and equipment utilization. Cost estimation and financing of constructed facilities. Contracting, construction planning and fundamental scheduling procedures. Cost control, monitoring and accounting for construction.
Prerequisite: 21-120.

12-421 Engineering Economics
Fall: 6 units
Basic concepts of economic analysis and evaluation of alternative engineering projects for capital investment. Consideration of time value of money and common merit measures such as net present value and internal rate of return. Selection of independent projects and mutually exclusive proposals, using various methods of analysis. Capital budgeting and project financing. Influence of price level changes, depreciation and taxation on choice of alternatives. Uncertainty and risk in operation and financing. Important factors affecting investment decisions for private and public projects. Senior Standing in Civil Engineering or approval of instructor.
Prerequisite: 21-120.

12-600 AutoCAD
Fall: 3 units
The course provides an introduction to the fundamentals of computer-aided design (CAD) software. Students learn how to set up CAD projects using Autodesk’s AutoCAD software. Topics include coordinates, lines, circles, arcs, zooms, snaps and grids, text, views, layers, lines, blocks, reference files, dimensioning, isometrics, 3D commands, surfaces, solids, and more. CAD standards for layers, plotting, and symbol libraries are also covered. The course includes development of a CAD project by each student. Prerequisites: None.

12-604 Transportation Engineering
Spring: 9 units
Introduction to traffic engineering and highway design providing practical experience that can be used directly in the workforce. Course material will provide a solid foundation in preparing for the Professional Engineer exam. The course incorporates the "soft" side of transportation engineering with tasks such as traffic analyses and traffic studies and the "hard" side of transportation engineering including traffic signal design, signing design, pavement marking design, maintenance and protection of traffic during construction design, and highway design.

12-605 Design and Construction
Fall: 9 units
Introduction to construction project management from owner’s perspective in organizing planning, design, construction and operation as an integrated process. Examination of labor productivity, material management and equipment utilization. Cost estimation and financing of constructed facilities. Cost control, monitoring and accounting for construction.
Prerequisite for Design Minors. Corequisite: 12-301.

12-610 Special Topic
Spring: 9 units
This course is intended to provide a comprehensive overview of the life cycle of the facility development process and of relevant project management techniques. While primary emphasis is on the construction phase, the techniques and perspective apply to the other phases of the facility development process as well. Students learn not only how to develop construction estimates and schedules, but also, globalization issues, methods to work on multicultural teams, negotiation techniques, and methods to improve inter/collaboration enhanced by the use of Information Technology. Students work in international teams to collaborate from remote locations via the Internet taking maximum advantage of information technology using commercially available software. Students also report on lessons learned on working with different cultures.

12-611 Project Management Construction
Fall: 9 units
12-629 Environmental Microbiology for Engineers
Fall: 9 units
This class provides a general introduction to microorganisms in natural and engineered environments. Selected topics include: cellular architecture, energetics and energy conservation, growth and catabolism; evolution and genetics; population and community dynamics; water and soil microbiology; biogeochemical cycling; biofilms; and microorganisms in wastewater, pollution attenuation, and bioremediation. Prerequisite: 03-121.

12-631 Structural Design
Spring: 12 units
Design of structural members for bending moment, shear force, axial force, and combined axial force and bending. Reinforced concrete, structural steel, and composite beam construction are considered. Buckling effects in columns, beams and local plate segments are treated. Serviceability limits such as deflection and cracking are addressed. Design projects include the determination of loads and the selection of system geometry. Prerequisite: 12-231. Corequisites: 27-357, 12-358.

12-635 Structural Analysis
Fall: 9 units
Classical and matrix-based methods of structural analysis; energy principles in structural mechanics. Basic concepts of force and displacement methods for analyzing redundant structural systems. Matrix methods utilizing the flexibility (force) and stiffness (displacement) concepts. Prerequisite: solid mechanics, fundamental matrix algebra. Prerequisite: 12-231.

12-636 Geotechnical Engineering
Spring: 9 units
Behavior of geotechnical structures; engineering design of geotechnical structures considering failure modes; uncertainties; economic issues, required design formats and relevant code provisions; performance requirements for foundations, subsurface investigations; allowable stress and LRFD design approaches; reliability-based design; shallow foundations; deep foundations; retaining structures; reinforced concrete foundations. Prerequisite: 12-335.

12-648 Civil Engineering Project
Fall and Spring
This course is designed to give students the opportunity to work on an open-ended project under the direction of a faculty member in the Civil & Environmental Engineering department. To register for this course, a student must have the approval of the faculty member for both the research topic and the number of units. A student in this course must write a proposal and submit progress reports to the advisor. The student must also make a formal presentation of the project results and submit a final report to the department. Senior standing in CEE and permission of the project advisor Units: 9-12.

12-651 Air Quality Engineering
Fall: 9 units
Problems and methodologies for studies of environmental management, with an emphasis on air pollution. Key topics include sources of pollutants, focusing on combustion chemistry for a hydrocarbon fuel; behavior of gaseous and particulate pollutants in the atmosphere including the role of meteorology and the use of dispersion equations; effects of pollutants on human health and global climate; and procedures by which air pollution standards are developed and enforced by regulatory agencies. Statistical treatment of data is included at several places in the course. Prerequisites: 12-351 and 12-355.

12-657 Water Resources Engineering
Spring: 9 units
Principles and applications of open channel flow. Hydrology of surface and ground water sources and the estimation of water requirements. Planning and design of water distribution and wastewater and storm water collection systems. This course is offered every other spring semester. Prerequisite: 12-351. Corequisite: 12-355.

12-658 Hydraulic Structures
Spring: 9 units
Theory and practice of design of riverine and coastal structures, including dams, levees, bridge piers, culverts, jetties and groins, seawalls, breakwaters, marinas, and harbors. Key related concepts from surface and ground water hydrology, and wave mechanics. This course is offered every other spring semester. Corequisite: 12-355.

12-659 Special Topics: Matlab
Fall: 6 units
This mini course is designed to be a practical introduction to engineering scientific computation. The topics of this class will include basic matrix computation, solving ordinary and partial differential equations, solving systems of linear equations, computing eigenvalues and eigenvectors, and basic signal processing and neural network techniques. Throughout the course, these scientific computation tools will be demonstrated using interactive scientific software called MATLAB.

12-671 Special Topics: Fundamental Concepts of Computing in CEE
Fall: 6 units
This course will introduce students to the important concepts of computing related to civil and environmental engineering. The course will briefly describe the form and operation of modern computational devices, the data structures and algorithms that are used in many of the computations that support CEE software applications, and explore the frontier of applying advanced computing in civil and environmental engineering. Prerequisites: 12-271.

12-690 Independent Study
Fall and Spring
In-depth investigation of a special topic in Civil and Environmental Engineering under the direction of a faculty member. The topic usually involves open-ended problems whose solution requires some elements of syntheses, analysis, construction, testing and evaluation of an engineering device or system. Junior or Senior Standing or with instructor permission in Civil and Environmental Engineering. Faculty approval required. 3 to 12 units.

12-702 Fundamentals of Water Quality Engineering
Fall: 12 units
This course is a systematic overview of water quality engineering designed for students with no prior civil and environmental engineering background. Topics examined include physical, chemical, and biological characteristics of water; common water pollutants; basic water chemistry and microbiology; mass and energy balances and their use in reactor analysis; physical, chemical and biological processes affecting natural water quality and the use of these processes in water supply and wastewater management systems; and selected problems in surface water and groundwater quality management. A background in college-level general chemistry, physics, calculus, and differential equations is assumed.

12-704 Probability and Estimation Methods for Engineering Systems
Fall: 12 units
Overview of rules of probability, random variables, probability distribution functions, and random processes for estimating the parameters of probability models and related statistical inference. Application to the analysis and design of engineered systems under conditions of variability and uncertainty. Prerequisites: 36-211, or 36-220 or equivalent.

12-712 Introduction to Sustainable Engineering
Fall: 12 units
This course begins with an overview of the concept of sustainability, including changing attitudes and values toward technology and the environment through the twentieth century. Models for population growth, global food production, and global water resources are then presented, and current problems such as land use, urbanization, and energy and material resources are discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Prerequisite: senior/graduate standing in engineering or permission of the instructor.

12-713 Industrial Ecology and Sustainable Engineering Design
Fall: 12 units
This course uses the context established in 12-712 to explore the solution space of engineers in tackling basic problems facing human civilization. The course begins with the concept of a system, using the earth’s life support systems as examples. The potential damage of conventional engineering decisions on these life support systems is discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Finally, the principles and tools of sustainable engineering are used to explore solutions to some of the most challenging problems identified in 12-712. Prerequisite: 12-712.
12-714 Environmental Life Cycle Assessment
Spring: 12 units
Cradle-to-grave analysis of new products, processes and policies is important to avoid undue environmental harm and achieve extended product responsibility. This course provides an overview of approaches and methods for life cycle assessment and for green design of typical products and processes using the ISO 14040 family of standards. This includes goal and scope definition, inventory analysis, life cycle impact assessment (LCIA), interpretation, and guidance for decision support. Process-based analysis models, input-output and hybrid approaches are presented for life cycle assessment. Example software such as MATLAB, Excel, and SimaPro are introduced and used in assignments. A group life cycle assessment project consistent with the principles and tools of sustainability to solve real-world engineering problems is required. Prerequisites: 12-421 or 12-706 or equivalent; 12-712
Prerequisites: (12-421 and 12-706) or (12-712).

12-718 Sustainable Engineering Project
Spring: 12 units
This course will integrate and exercise students in a significant sustainable engineering system development project that is team-based and built upon the knowledge, skills, and technologies learned in the core and specialist courses. Prerequisite: 12-740 through 12-744, or permission of Instructor or Core Course 12-712, 12-713, or permission of instructor for 12-718 (corequisite 12-714).

12-740 Data Acquisition
Fall: 6 units
The intent of this course is to introduce students to the concepts, approaches and implementation issues associated with data acquisition for infrastructure systems. Students will be introduced to the types of data that is collected about infrastructure systems, excitation mechanisms, sensing technologies, data acquisition using sensors, signal pre-processing and post-processing techniques, and use of sensing in a variety of applications in construction and infrastructure management. Students will also gain experience with data acquisition hardware and software.

12-741 Data Management
Fall: 6 units
The intent of this course is to introduce students to database management systems and to knowledge discovery in database principles. Students will learn how to develop powerful tools for efficiently managing large amounts of civil engineering data so that it may persist safely over long periods of time. Students will be introduced to relational database systems and structured query languages. They will also be exposed to other existing data models. Students also will be introduced to data mining and analysis tools to discover patterns and knowledge from data.

Computational Biology Courses

02-223 How to Analyze Your Own Genome
Fall: 9 units
Do you want to know how to discover the tendencies hidden in your genome? Since the first draft of a human genome sequence became available about a decade ago, the cost of genome sequencing has decreased dramatically. It is expected that personal genome sequencing will become a routine part of medical examinations for patients in clinics for diagnostic and prognostic purposes. Personal genome information will also play an increasing role in lifestyle choices as people take into account their own genetic tendencies. Commercial services such as 23andMe have already taken first steps in this direction. Computational methods for mining large-scale genome data are being developed to unravel the genetic basis of diseases and to assist doctors in clinics. This course introduces students to the biological, computational, and ethical issues that concern the use of personal genome information in health maintenance, medical practice, biomedical research, and policymaking. The course focuses on practical issues, using individual genome sequences (such as Nobel prize winner James Watson) and other population-level genome data. Without requiring any background in biological or computational sciences, the course begins with an overview of topics from genetics, molecular biology, statistics, and machine learning that are relevant to the modern personal genome era. The class then covers scientific issues such as how to discover your genetic ancestry, how to learn from genomes about the migration and evolution of the human population, and how natural selection shaped our genomes. The class will discuss medical aspects such as predicting whether you will develop diseases such as diabetes based on your own genome, discovering disease-causing genetic mutations, and how genetic information can be used to recommend clinical treatments. It closes with consideration of the complex policy issues that our society will face as this personal.

02-250 Introduction to Computational Biology
12 units

02-251 Introduction to computational Molecular Biology
6 units

02-252 Introduction to Computational Cell Biology
6 units

02-261 Quantitative Cell and Molecular Biology Laboratory
Fall: 9 units
This is an introductory laboratory-based course designed to teach basic biological laboratory skills used in exploring the quantitative nature of biological systems and the reasoning required for performing research in computational biology. Over the course of the semester, students will perform many experiments and quantitatively analyze the results of these experiments. Students will also have the opportunity to design experiments based on the data they collect. During this course students will be using traditional, well-developed techniques to answer open questions. “What changes occur in the splicing of genes as an organism ages? What changes do cells undergo during apoptosis? Understanding the results of these experiments will require students to think critically about the results they generate, the appropriate controls required to confirm results, and the biological context within which these results were obtained. During this course students will gain experience in many aspects of scientific research, including: Sequencing and analyzing a large and diverse population of DNA Designing and performing PCR for a variety of analyses Maintaining cell cultures Taking brightfield and fluorescent microscopy images Developing methods for automated analysis of cell images Communicating results to peers and colleagues Course Outline: 1 – 3 hour lab per week 1 – 1 hour lecture per week 9 units.

02-422 Advanced Algorithms for Computational Structural Biology
Fall: 9 units

02-450 Automation of Biological Research
Fall: 9 units
Biology has been revolutionized by automated methods for generating large amounts of data on diverse biological processes. This, in addition to the finding that many more components are involved in each process than had earlier been thought, has led to a transition from a “reductionist” paradigm of biological research involving detailed study of single molecules or events to a “systems biology” paradigm involving comprehensive, systematic studies combined with computational data analysis. Integration of data from many types of experiments will be required to construct detailed, predictive models of cell, tissue or organism behaviors, and the complexity of the systems suggests that need for these models to be constructed automatically. This will require iterative cycles of acquisition, analysis, modeling, and experimental design, since it is not feasible to do all possible biological experiments. This course will cover a range of automated biological research methods (especially high-throughput, robotic methods for protein structure determination, gene sequencing, cell-based drug screening, and nanosays), and a range of relevant computational methods (especially active learning, proactive learning, compressed sensing and model structure learning). It assumes a basic knowledge of machine learning. Class sessions will consist of a combination of lectures and discussions of important research papers. Grading will be based on class participation, homeworks, and a final project. Prerequisites: 15-381 or instructor permission.

02-500 Undergraduate Research in Computational Biology
All Semesters

02-510 Computational Genomics
Fall: 12 units

02-512 Computational Methods for Biological Modeling and Simulation
Fall: 9 units
This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological applications. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work will include problems sets with significant programming components and independent or group final projects.

02-530 Cells and Systems Modeling
Spring: 12 units

02-740 Bioimage Informatics
12 units
Computer Science Courses

15-050 Study Abroad
All Semesters
Students who are interested in studying abroad should first contact the Office of International Education. More information on Study Abroad is available on OIE’s Study Abroad page and at the CS Undergraduate Office.

15-075 Computer Science Co-Op
All Semesters
Students who are interested in a Co-Op experience with an external employer typically do so in their junior year. A Co-Op is distinguished from a summer internship in that it encompasses a summer and a contiguous semester, either Spring-Summer or Summer-Fall. A list of companies who are interested in hiring Co-Op students is available from the SCS Career Consultant at the Career Center. More information on the Computer Science Co-Op program is available at the CS Undergraduate Office.

15-090 Computer Science Practicum
All Semesters: 3 units
This course is for international students who are interested in working for Curricular Practical Training (CPT). Such students interested in CPT must first be authorized by the Office of International Education before being able to enroll in the Practicum course. More information on CPT is available on OIE’s Foreign Student Employment page and at the CS Undergraduate Office.

15-101 Exploring Programming with Alice
Fall and Spring: 10 units
The course is intended for students with little or no prior programming experience and need a one semester experience with programming. An introduction to computer programming with Alice and Java. This course is designed for students who have had no previous programming experience. The Alice development environment uses 3D graphics to introduce students to computer programming and the Java language. Students will write both Alice and Java programs throughout the course. Topics to be covered include program design and problem solving, objects and classes, fields, methods and parameters, basic data types and defined operators, control structures (selection and loops), and lists.

15-110 Principles of Computing
All Semesters: 10 units
A course in fundamental computing principles for students with minimal or no computing background. Programming constructs: sequencing, selection, iteration, and recursion. Data organization: arrays and lists. Use of abstraction in computing: data representation, computer organization, computer networks, functional decomposition, and application programming interfaces. Use of computational principles in problem-solving: divide and conquer, randomness, and concurrency. Classification of computational problems based on complexity, non-computable functions, and using heuristics to find reasonable solutions to complex problems. Social, ethical and legal issues associated with the development of new computing artifacts will also be discussed.

15-112 Fundamentals of Programming and Computer Science
All Semesters: 12 units
A technical introduction to the fundamentals of programming with an emphasis on producing clear, robust, and reasonably efficient code using top-down design, informal analysis, and effective testing and debugging. Starting from first principles, we will cover a large subset of the Python programming language, including its standard libraries and programming paradigms. We will also target numerous deployment scenarios, including standalone programs, shell scripts, and web-based applications. This course assumes no prior programming experience. Even so, it is a fast-paced and rigorous preparation for 15-122. Students seeking a more gentle introduction to computer science should consider first taking 15-110. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.

15-121 Introduction to Data Structures
Fall and Spring: 10 units
A continuation of the process of program design and analysis for students with some prior programming experience (functions, loops, and arrays, not necessarily in Java). The course reinforces object-oriented programming techniques in Java and covers data aggregates, data structures (e.g., linked lists, stacks, queues, trees, and graphs), and an introduction to the analysis of algorithms that operate on those data structures. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course. Prerequisites: 15-112 or 15-110.

15-122 Principles of Imperative Computation
All Semesters: 10 units
For students with a basic understanding of programming (variables, expressions, loops, arrays, functions). Teaches imperative programming and methods for ensuring the correctness of programs. Students will learn the process and concepts needed to go from high-level descriptions of algorithms to correct imperative implementations, with specific application to data structures and algorithms. Much of the course will be conducted in a subset of C amenable to verification, with a transition to full C near the end. This course prepares students for 15-213 and 15-210. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course. Prerequisite: 15-112 Corequisite: 21-127.

15-128 Freshman Immigration Course
Fall: 1 unit
The Freshman Immigration Course is taken by first-semester Computer Science majors on the Pittsburgh campus. The course is designed to acquaint incoming majors with computer science at CMU. Takes range from historical perspectives in the field to descriptions of the cutting edge research being conducted in the School of Computer Science. 15-128 is a one unit course and is graded pass/fail. Enrollment is limited to SCS Freshmen ONL.

15-129 Freshman Immigration Course II
Fall: 3 units
This course is offered at our Qatar campus only. Students and instructors will solve different problems each week by searching the Web and other likely places for answers. The problems will be submitted by other faculty who will grade the quality of the answers. Students will learn strategies and techniques for finding information on the Web more efficiently; learn when to start with a search engine, a subject-oriented directory, or other tools; explore and practice using advanced search syntax for major search engines; experience specialized search engines for images, sound, multimedia, newsgroups, and discussion lists as well as subject-specific search engines; discover valuable resources to help keep you up-to-date in this fast-changing environment.

15-150 Principles of Functional Programming
Fall and Spring: 10 units
An introduction to programming based on a “functional” model of computation. The functional model is a natural generalization of algebra in which programs are formulas that describe the output of a computation in terms of its inputs—that is, as a function. But instead of being confined to real- or complex-valued functions, the functional model extends the algebraic view to a very rich class of data types, including not only aggregates built up from other types, but also functions themselves as values. This course is an introduction to programming that is focused on the central concepts of function and type. One major theme is the interplay between inductive types, which are built up incrementally; recursive functions, which compute over inductive types by decomposition; and proof by structural induction, which is used to prove the correctness and time complexity of a recursive function. Another major theme is the role of types in structuring large programs into separate modules, and the integration of imperative programming through the introduction of data types whose values may be altered during computation. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course. Prerequisites: 21-127 and 15-112.

15-210 Parallel and Sequential Data Structures and Algorithms
Fall and Spring: 12 units
Teaches students about how to design, analyze, and program algorithms and data structures. The course emphasizes parallel algorithms and analysis, and how sequential algorithms can be considered a special case. The course goes more theoretical content on algorithm analysis than 15-222 and 15-150 while still including a significant programming component and covering a variety of practical applications such as problems in data analysis, graphics, text processing, and the computational sciences. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course. Prerequisites: 15-122 and 15-150.
15-211 Fundamental Data Structures and Algorithms  
Fall and Spring: 12 units  
Fundamental programming concepts are presented together with supporting theoretical foundations and practical applications. This course emphasizes the practical application of techniques for writing and analyzing programs: data abstraction, program verification, and performance analysis. These techniques are applied in the design and analysis of fundamental algorithms and data structures. The course is currently taught in Java. NOTE: students must achieve a C or better in order to use this course to satisfy the prerequisite for any subsequent Computer Science course. Prerequisites: 21-127 and 15-121.

15-213 Introduction to Computer Systems  
Fall and Spring: 12 units  
This course provides a programmer's view of how computer systems execute programs, store information, and communicate. It enables students to become more effective programmers, especially in dealing with issues of performance, portability and robustness. It also serves as a foundation for courses on compilers, networks, operating systems, and computer architecture, where a deeper understanding of systems-level issues is required. Topics covered include: machine-level code and its generation by optimizing compilers, performance evaluation and optimization, computer arithmetic, memory organization and management, networking technology and protocols, and supporting concurrent computation. NOTE: students must achieve a C or better in order to use this course to satisfy the prerequisite for any subsequent Computer Science course. Prerequisite: 15-122.

15-214 Principles of Software Construction: Objects, Design, and Concurrency  
Fall and Spring: 12 units  
Software engineers today are less likely to design data structures and algorithms from scratch and more likely to build systems from library and framework components. In this course, students engage with concepts related to the construction of software systems at scale, building on their understanding of the basic building blocks of data structures, algorithms, program structures, and computer structures. The course covers technical topics in four areas: (1) concepts of design for complex systems, (2) object oriented programming, (3) static and dynamic analysis for programs, and (4) concurrent and distributed software. Student assignments involve engagement with complex software such as distributed massively multiplayer game systems and frameworks for graphical user interaction. Prerequisite: 15-122.

15-221 Technical Communication for Computer Scientists  
All Semesters: 9 units  
The course is designed for sophomore computer science majors to improve their abilities in practical, professional communications (both written and oral). It aims to help students compose clear, concise technical writings and oral presentations for multi-level audiences. Assignments include technical definitions, descriptions, instructions, process explanations, abstracts, memos, and research reports. Assignments may incorporate recent computer science research at Carnegie Mellon, projects in related technical courses, and professional case studies. Sophomores will likely find the course more useful if they have either had an internship or faculty-supervised research, including SURF projects prior to enrollment. Prerequisite: 76-101.

15-251 Great Theoretical Ideas in Computer Science  
Fall and Spring: 12 units  
This course is about how to use theoretical ideas to formulate and solve problems in computer science. It integrates mathematical material with general problem solving techniques and computer science applications. Examples are drawn from Algorithms, Complexity Theory, Game Theory, Probability Theory, Graph Theory, Automata Theory, Algebra, Cryptography, and Combinatorics. Assignments involve both mathematical proofs and programming. NOTE: students must achieve a C or better in order to use this course to satisfy the prerequisite for any subsequent Computer Science course. Prerequisites: 15-112 and 21-127.

15-295 Special Topic: Competition Programming and Problem Solving  
Fall and Spring  
Each year, Carnegie Mellon fields two teams for participation in the ACM-ICPC Regional Programming Contest. During many recent years, one of those teams has earned the right to represent Carnegie Mellon at the ACM-ICPC World Finals. This course is a vehicle for those who consistently and rigorously train in preparation for the contests to earn course credit for their effort and achievement. Preparation involves the study of algorithms, the practice of programming and debugging, the development of test sets, and the growth of team, communication, and problem solving skills. Neither the course grade nor the number of units earned are dependent on ranking in any contest. Students are not required to earn course credit to participate in practices or to compete in ACM-ICPC events. Consistent, disciplined participation in team practices and associated individual preparation earns three (3) units of credit. Six (6) units of credit are possible for those who routinely complete significant homework and/or teamwork assignments outside of normal group meetings. Students interested in the course should attend during the first week of classes to discuss enrollment details. Prerequisite: 15-122.

15-312 Foundations of Programming Languages  
Spring: 12 units  
This course discusses in depth many of the concepts underlying the design, definition, implementation, and use of modern programming languages. Formal approaches to defining the syntax and semantics are used to describe the fundamental concepts underlying programming languages. A variety of programming paradigms are covered such as imperative, functional, logic, and concurrent programming. In addition to the formal studies, experience with programming in the languages is used to illustrate how different design goals can lead to radically different languages and models of computation. Prerequisites: (15-210 and 15-251) or (15-212).

15-313 Foundations of Software Engineering  
Fall: 12 units  
Students gain exposure to the fundamentals of modern software engineering. This includes both core CS technical knowledge and the means by which this knowledge can be applied in the practical engineering of complex software. Topics related to software artifacts include design models, patterns, coding, static and dynamic analysis, testing and inspection, measurement, and software architecture and frameworks. Topics related to software process include modeling, requirements engineering, process models and evaluation, team development, and supply chain issues including outsourcing and open source. This course has a strong technical focus, and will include both written and programming assignments. Students will get experience with modern software engineering tools and, later in the semester, create one of their own. Prerequisite: 15-214.

15-317 Constructive Logic  
Fall: 9 units  
This multidisciplinary junior-level course is designed to provide a thorough introduction to modern constructive logic, its roots in philosophy, its numerous applications in computer science, and its mathematical properties. Some of the topics to be covered are intuitionistic logic, inductive definitions, functional programming, type theory, realizability, connections between classical and constructive logic, decidable classes. This course counts as a Fundamentals course in the Computer Science major. Prerequisites: 15-210 or 15-212.
15-354 Modern Computer Algebra
Fall: 9 units
The goal of this course is to investigate the relationship between algebra and computation. The course is designed to expose students to algorithms used for symbolic computation, as well as to the concepts from modern algebra which are applied to the development of these algorithms. This course provides a hands-on introduction to many of the most important ideas used in symbolic mathematical computation, which involves solving system of polynomial equations (via Groebner bases), analytic integration, and solving linear difference equations. Throughout the course the computer algebra system Mathematica will be used for computation. Prerequisite: 15-251.

15-359 Probability and Computing
Spring: 12 units
Probability theory has become indispensable in computer science. In areas such as artificial intelligence and computer science theory, probabilistic methods and ideas based on randomization are central. In other areas such as networks and systems, probability is becoming an increasingly useful framework for handling uncertainty and modeling the patterns of data that occur in complex systems. This course gives an introduction to probability as it is used in computer science theory and practice, drawing on applications and current research developments as motivation and context. Topics include combinatorial probability and random graphs, heavy tail distributions, concentration inequalities, various randomized algorithms, sampling random variables and computer simulation, and Markov chains and their many applications, from Web search engines to models of network protocols. The course will assume familiarity with 3-D calculus and linear algebra. Prerequisites: 15-210 and 15-251 and 21-241 and 21-259.

15-381 Artificial Intelligence: Representation and Problem Solving
Fall: 9 units
This course is about the theory and practice of Artificial Intelligence. We will study modern techniques for computers to represent task-relevant information and make intelligent (i.e. satisfying or optimal) decisions towards the achievement of goals. The search and problem solving methods are applicable throughout a large range of industrial, civil, medical, financial, robotic, and information systems. We will investigate questions about AI systems such as: how to represent knowledge, how to effectively generate appropriate sequences of actions and how to search among alternatives to find optimal or near-optimal solutions. We will also explore how to deal with uncertainty in the world, how to learn from experience, and how to learn decision rules from data. We expect that by the end of the course students will have a thorough understanding of the algorithmic foundations of AI, how probability and AI are closely interrelated, and how automated agents learn. We also expect students to acquire a strong appreciation of the big-picture aspects of developing fully autonomous intelligent agents. Other lectures will introduce additional aspects of AI, including natural language processing, web-based search engines, industrial applications, autonomous robotics, and economic/game-theoretic decision making. Prerequisites: 15-122 or 15-211.
15-386 Neural Computation
Spring: 9 units
Computational neuroscience is an interdisciplinary science that seeks to understand how the brain computes to achieve natural intelligence. It seeks to understand the computational principles and mechanisms of intelligent behaviors and mental abilities — such as perception, language, motor control, and learning — by building artificial systems and computational models with the same capabilities. This course explores how neurons encode and process information, adapt and learn, communicate, cooperate, compete and compute at the individual level as well as at the levels of networks and systems. It will introduce basic concepts in computational modeling, information theory, signal processing, system analysis, statistical and probabilistic inference. Concrete examples will be drawn from the visual system and the motor systems, and studied from computational, psychological and biological perspectives. Students will learn to perform computational experiments using Matlab and quantitative studies of neurons and neuronal networks.
Prerequisites: 21-122 and 15-112.

15-390 Entrepreneurship for Computer Science
Fall: 9 units
This course is an introduction to Entrepreneurship designed to develop skills related to entrepreneurship and innovation for non-business undergraduate and graduate students in the School of Computer Science. The course assumes no background courses in business and is appropriate for those who are interested in bringing innovations to market either through new companies or existing companies. The course provides an overview of entrepreneurship and innovation, develops an entrepreneurial frame of mind, and provides a framework for learning the rudiments of how to generate ideas. Students come up with or are presented with potential ideas and learn how to develop these ideas into opportunities, and to explore their potential for becoming viable businesses. They learn how to do market research, to develop go-to-market strategies, value propositions and to differentiate their products or services from potential competitors. The focus is on understanding and developing strategies for approaching the key elements of the entrepreneurial process... opportunity, resources and team. The course consists of a balance of lectures, case studies and encounters with entrepreneurs, investors and business professionals. The students are exposed to financial and intellectual property issues, and encounter a real-world perspective on entrepreneurship, innovation and leadership. The output of the course is a mini-business plan or venture opportunity screening document that can be developed into a business plan in a subsequent course entitled New Venture Creation or through independent study.

15-392 Special Topic: Secure Programming
Spring: 9 units
This course provides a detailed explanation of common programming errors in C and C++ and describes how these errors can lead to software systems that are vulnerable to exploitation. The course concentrates on security issues intrinsic to the C and C++ programming languages and associated libraries. It does not emphasize security issues involving interactions with external systems such as databases and web servers, as these are rich topics on their own. Topics to be covered include the secure and insecure use of integers, arrays, strings, dynamic memory, formatted input/output functions, and file I/O.
Prerequisite: 15-213.

15-410 Operating System Design and Implementation
Fall and Spring: 12 units
Operating System Design and Implementation is a rigorous hands-on introduction to the principles and practice of operating systems. The core experience is writing a small Unix-inspired OS kernel, in C with some x86 assembly language, which runs on a PC hardware simulator (and on actual PC hardware if you wish). Work is done in two-person teams, and “team programming” skills (source control, modularity, documentation) are emphasized. The size and scope of the programming assignments typically result in students significantly developing their design, implementation, and debugging abilities. Core concepts include the process model, virtual memory, threads, synchronization, and deadlock; the course also surveys higher-level OS topics including file systems, interprocess communication, networking, and security. Students, especially graduate students, who have not satisfied the prerequisite at Carnegie Mellon are strongly cautioned - to enter the class you must be able to write a storage allocator in C, use a debugger, understand 2’s-complement arithmetic, and translate between C and x86 assembly language. The instructor may require you to complete a skills assessment exercise before the first week of the semester in order to remain registered in the class. Auditing: this course is usually full, and we generally receive many more requests to audit than we can accept. If you wish to audit, please have your advisor contact us before the semester begins to discuss your educational goals.
Prerequisite: 15-213.

15-411 Compiler Design
Fall: 12 units
This course covers the design and implementation of compiler and run-time systems for high-level languages, and examines the interaction between language design, compiler design, and run-time organization. Topics covered include syntactic and lexical analysis, handling of user-defined types and type-checking, context analysis, code generation and optimization, and memory management and run-time organization.
Prerequisites: 15-213 or 15-312.

15-412 Operating System Practicum
Fall
The goal of this class is for students to acquire hands-on experience with operating-system code as it is developed and deployed in the real world. Groups of two to four students will select, build, install, and become familiar with an open-source operating system project; propose a significant extension or upgrade to that project; and develop a production-quality implementation meeting the coding standards of that project. Unless infeasible, the results will be submitted to the project for inclusion in the code base. Variations on this theme are possible at the discretion of the instructor. For example, it may be possible to work within the context of a non-operating-system software infrastructure project (window system, web server, or embedded network device kernel) or to extend a 15-410 student kernel. In some situations students may work alone. Group membership and unit count (9 units versus 12) will be decided by the third week of the semester. Contributing to a real-world project will involve engaging in some mixture of messy, potentially open-ended activities such as: learning a revision control system, writing a short design document, creating and updating a simple project plan, participating in an informal code review, synthesizing scattered information about hardware and software, classifying and/or reading large amounts of code written by various people over a long period of time, etc.
Prerequisite: 15-410.

15-413 Software Engineering Practicum
Spring
This course is modeled after the successful MSE studio and MSIT practicum experiences used in the ISR software engineering masters programs. Students will carry out a semester-long project for a real client in small teams. A few lectures at the beginning of the course will introduce the process, tools, and documents to be used in the course, all of which will be specified by the instructors. Throughout the project, groups will be mentored through weekly team meetings with faculty. Teams will make regular presentations on the following topics: risk management, project planning, requirements, architecture, detailed design, quality assurance, final product presentations, and reflections on the experience. Teams will also deliver documents on each of the above topics. Evaluation will be based on the in-class presentations, process and product documentation deliverables, how well the teams follow SE practices as judged by their mentor, and finally the client’s satisfaction with the product. Individual grades within a team will be influenced by peer reviews, individual reflection documents, mentor impressions, and presentation performance. Students will leave the course with a firsthand understanding of the software engineering realities that drive SE practices. They will have concrete experience with these practices, and will have engaged in active reflection on this experience. They will have teamwork, process, and product skills to support immediate competency in a software engineering organization, along with a deeper understanding that prepares them to evaluate the new processes and techniques they will encounter in the workplace.
Prerequisite: 15-413.

15-414 Bug Catching: Automated Program Verification and Testing
Fall: 9 units
Many CS and ECE students will be developing software and hardware that must be ultra reliable at some point in their careers. Logical errors in such designs can be costly, even life threatening. There have already been a number of well publicized errors like the Intel Pentium floating point error and the Ariane 5 crash. In this course we will study tools for finding and preventing logical errors. Three types of tools will be studied: automated theorem proving, state exploration techniques like model checking and tools based on static program analysis. Although students will learn the theoretical basis for such tools, the emphasis will be on actually using them on real examples. This course can be used to satisfy the Logic & Languages requirement for the Computer Science major.
Prerequisites: (15-122 or 15-211) and 15-251.)
15-415 Database Applications
Spring: 12 units
This course covers the fundamental topics for Database Management Systems: Database System Architectural Principles (ACID properties; data independence; data definition and data manipulation languages), Data models (entity-relationship and relational data models; data structures, integrity constraints, and operations for each data model; relational query languages; SOL, algebra, calculus), Theory of database design (functional dependencies; normal forms; dependency preservation; information loss), Query Optimization (equivalence of expressions, algebraic manipulation; optimization of selections and joins), Storage Strategies (indices, B-trees, hashing), Query Processing (execution of sort, join, and aggregation operators), and Transaction Processing (recovery and concurrency control). Prerequisites: (15-210) or (15-211 and 15-213).

15-418 Parallel Computer Architecture and Programming
Spring: 12 units
The fundamental principles and engineering tradeoffs involved in designing modern parallel computers, as well as the programming techniques to effectively utilize these machines. Topics include naming shared data, synchronizing threads, and the latency and bandwidth associated with communication. Case studies on shared-memory, message-passing, data-parallel and dataflow machines will be used to illustrate these techniques and tradeoffs. Programming assignments will be performed on one or more commercial multiprocessors, and there will be a significant course project. Prerequisite: 15-213.

15-421 Web Commerce, Security and Privacy
Fall: 12 units
The objective of this course is to introduce students to the technologies of Web Commerce, Security and Privacy as well as to related business, policy and usability issues. Content: Over the past 15 years, the Web has become an integral part of our daily life, whether at home or at work. This course provides students with an overview of the technologies and practices associated with Web Security, Privacy and Commerce. In the process, students will learn what it takes to design and develop successful web applications and services, reconciling security, privacy, usability and business considerations. The course is organized around two parts: Part I - Web Security & Privacy Technologies The big picture, gentle introduction to cryptography, digital signatures, key management, authentication, Internet security protocols, certificates & PKI, decentralized trust management, privacy enhancing technologies, electronic payments. Part II - Web Commerce The big picture, Internet marketing & personalization, search engines, B2B and electronic markets, P2P, Web 2.0, Mobile Commerce, social networking. Format: Lectures (including guest lectures), discussions, student presentations, and class projects. Prerequisites: 15-122 or 15-211.

15-437 Web Application Development
Fall and Spring: 12 units
This course will introduce concepts in programming web application servers. We will study the fundamental architectural elements of programming web sites that produce content dynamically. The primary technology introduced will be Java Servlets and Java Server Pages (JSPs), but we will cover related topics as necessary so that students can build significant applications. Such topics include: HTTP, HTML and XML, JavaBeans, Design Patterns, Tag Libraries, Relational Databases, Object-Relation Mapping tools, Security, Web Services, Frameworks, Internationalization, and Scalability and Performance issues. This course is recommended for students contemplating enrollment in 15-413 (the Software Engineering Project), since many of the projects in 15-413 are expected to be web-based. Students must be comfortable programming in Java to register for this course. Students must provide their own computer hardware for this course. Please see the Related URL above for more information. Prerequisite: 15-214.

15-440 Distributed Systems
Fall: 12 units
The goals of this course are twofold: First, for students to gain an understanding of the principles and techniques behind the design of distributed systems, such as locking, concurrency, scheduling, and communication across the network. Second, for students to gain practical experience designing, implementing, and debugging real distributed systems. The major themes this course will teach include scalability, scheduling, concurrency and concurrent programming, naming, abstraction and modularity, imperfect communication and other types of failure, protection from accidental and malicious harm, optimism, and the use of instrumentation and monitoring and debugging tools in problem solving. As the creation and management of software systems is a fundamental goal of any undergraduate systems course, students will design, implement, and debug large programming projects. As a consequence, competency in both the C and Java programming languages is required. Prerequisite: 15-213.

15-441 Computer Networks
Fall and Spring: 12 units
The emphasis in this course will be on the basic performance and engineering trade-offs in the design and implementation of computer networks. To make the issues more concrete, the class includes several multi-week projects requiring significant design and implementation. The goal is for students to learn not only what computer networks are and how they work today, but also why they are designed the way they are and how they are likely to evolve in the future. We will draw examples primarily from the Internet. Topics to be covered include: network architecture, routing, congestion/flow/error control, naming and addressing, peer-to-peer and the web, internetworking, and network security. Prerequisite: 15-213.

15-451 Algorithm Design and Analysis
Fall and Spring: 12 units
This course is about the design and analysis of algorithms. We study specific algorithms for a variety of problems, as well as general design and analysis techniques. Specific topics include searching, sorting, algorithms for graph problems, efficient data structures, lower bounds and NP-completeness. A variety of other topics may be covered at the discretion of the instructor. These include parallel algorithms, randomized algorithms, geometric algorithms, low level techniques for efficient programming, cryptography, and cryptographic protocols. Prerequisites: 15-251 and 15-210 and 21-241.

15-453 Formal Languages, Automata, and Computability
Spring: 9 units
An introduction to the fundamental ideas and models underlying computing: finite automata, regular sets, pushdown automata, context-free grammars, Turing machines, undecidability, and complexity theory. Prerequisites: 21-228 or 15-251.

15-462 Computer Graphics
Fall and Spring: 12 units
This course provides a comprehensive introduction to computer graphics modeling, animation, and rendering. Topics covered include basic image processing, geometric transformations, geometric modeling of curves and surfaces, animation, 3-D viewing, visibility algorithms, shading, and ray tracing. Prerequisites: (21-259 and 15-213 and 21-241) or (15-213 and 18-202).

15-463 Computational Photography
Fall: 12 units
Computational Photography is an emerging new field created by the convergence of computer graphics, computer vision and photography. Its role is to overcome the limitations of the traditional camera by using computational techniques to produce a richer, more vivid, perhaps more perceptually meaningful representation of our visual world. The aim of this advanced undergraduate course is to study ways in which samples from the real world (images and video) can be used to generate compelling computer graphics imagery. We will learn how to acquire, represent, and render scenes from digitized photographs. Several popular image-based algorithms will be presented, with an emphasis on using these techniques to build practical systems. This hands-on emphasis will be reflected in the programming assignments, in which students will have the opportunity to acquire their own images of indoor and outdoor scenes and develop the image analysis and synthesis tools needed to render the scenes on the computer. Prerequisites: (15-213 and 21-241 and 21-259) or (15-213 and 18-202).
15-464 Technical Animation  
Fall: 12 units  
This course introduces techniques for computer animation such as keyframing, procedural methods, motion capture, and simulation. The course also includes a brief overview of storyboarding, scene composition, lighting and sound track generation. The second half of the course will explore current research topics in computer animation such as dynamic simulation of flexible and rigid objects, automatically generated control systems, and evolution of behaviors. The course should be appropriate for graduate students in all areas and for advanced undergraduates.  
Prerequisite: 15-462.

15-465 Animation Art and Technology  
Spring: 12 units  
Animation Art and Technology is an interdisciplinary course cross-listed between Art and Computer Science. Faculty and teaching assistants from computer science and art teach the class as a team. It is a project-based course in which four to five interdisciplinary teams of students produce animations. Most of the animations have a substantive technical component and the students are challenged to consider innovation with content to be equal with the technical. The class includes basic tutorials for work in Maya leading toward more advanced applications and extensions of the software such as motion capture and algorithms for animating cloth, hair, particles, and grouping behaviors. The first class will meet in CPA room 303.  
Prerequisite: 15-462.

15-466 Computer Game Programming  
Spring: 12 units  
This course will cover tools and techniques for programming interactive games and virtual reality simulations. The course will focus primarily on programming aspects, including event loops and execution threads, graphics and animation in 2D and 3D, terrain/background representation, collision detection and physically-based modeling, game AI, and multi-user games and networking. Although this course has a heavy programming focus, other topics briefly covered will include the history of computer/video game technology, game genres and design principles, and the social impact of games. Students will design and program their own games or virtual reality simulations as individual class projects using OpenGL and other standard APIs commonly used in game programming.  
Prerequisite: 15-462.

15-486 Artificial Neural Networks  
Intermittent: 12 units  
Artificial neural networks combine ideas from machine learning, statistics, and pattern recognition. They draw inspiration from, and provide simplified formalizations of, theories about the workings of the brain. This course offers an introduction to neural networks for computer scientists and engineers. Prerequisites are undergraduate calculus and linear algebra, and solid programming skills. An undergraduate course in artificial intelligence or machine learning would provide helpful background but is not required. The course provides hands-on experience with a variety of neural network architectures implemented in MATLAB, and an in-depth look at problems in pattern recognition and knowledge representation. Topics covered include perceptrons, the LMS learning rule, fundamentals of pattern recognition, backpropagation learning, forward and inverse models in control theory, competitive learning, self-organizing feature maps, radial basis functions, the EM algorithm, Hopfield networks, Boltzmann machines, Hebbian machines, and general recurrent networks.  
Prerequisites: 15-212 and (21-241 or 18-202).

15-491 Special Topic: CMRoboBits: Creating Intelligent Robots  
Fall: 12 units  
Creating intelligent robots can be viewed as the integration of many pieces - "bits" - "RoboBits". This course will teach students such "RoboBits" for creating both single robots and groups of intelligent robots, with perception, cognition, and action. This Fall, students in the course will use the new HUMANOID robots - the NAO robots, www.aldebaran-robotics.com/eng/index.php. We will study robot motion, biped motion, vision processing, object recognition, cognitive architectures, planning, learning, and team work among robots and between robots and humans. The course will be a PROJECT-BASED course which will run in the CORAL lab (location TBD) in the new Gates building. The course will have weekly assignments to incrementally build the complete intelligent humanoid. Class weekly meetings of 2 hours will be on Mondays, Tuesdays, or Wednesdays TBD with the class. We will aim at enabling the humanoid robots to fully function in a mini-home environment, which we will construct during the course. Evaluation will be based on the weekly assignments.  
Prerequisite: 15-122.

15-492 Special Topic: Speech Processing  
Fall: 12 units  
Speech Processing offers a practical and theoretical understanding of how human speech can be processed by computers. It covers speech recognition, speech synthesis and spoken dialog systems. The course involves practicals where the student will build working speech recognition systems, build their own synthetic voice and build a complete telephone spoken dialog system. This work will be based on existing toolkits. Details of algorithms, techniques and limitations of state of the art speech systems will also be presented. This course is designed for students wishing understand how to process real data for real applications, applying statistical and machine learning techniques as well as working with limitations in the technology.  
Prerequisite: 15-122.

15-493 Special Topic: Cognitive Robotics  
Intermittent: 12 units  
Cognitive robotics is a new approach to robot programming based on high level primitives for perception and action. These primitives draw inspiration from ideas in cognitive science combined with state of the art robotics algorithms. Students will work with new ones using the Tekkotsu software framework on the Calliope robot, which includes a 5 degree-of-freedom arm with gripper, a Kinect camera on a pan/tilt mount, and Ubuntu Linux on a dual-core on-board netbook. Prior robotics experience is not necessary, but strong programming skills are required.  
Prerequisite: 15-214.

15-519 Independent Study in Programming Systems  
Fall and Spring

15-529 Independent Study in Human-Computer Interaction  
Fall and Spring

15-539 Independent Study in Computer Science Pedagogy  
Fall and Spring

15-540 Rapid Prototyping of Computer Systems  
Spring: 12 units  
This is a project-oriented course, which will deal with all four aspects of project development: the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time. Upon completion of this course the student will be able to: generate systems specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided development tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time.  
Prerequisite: 15-211.

15-549 Independent Study in Computer Systems  
Fall and Spring

15-559 Independent Study in Theoretical Computer Science  
Fall and Spring

15-569 Independent Study in Graphics  
Fall and Spring

15-579 Independent Study in Robotics  
Fall and Spring

15-589 Independent Study in Artificial Intelligence  
Fall and Spring

15-599 Undergraduate Thesis Research  
Fall and Spring  
Available only to students registered in the CS Senior Research Thesis Program. More information is available at the CS Undergraduate Office.
15-610 Engineering Distributed Systems
Spring: 12 units
This is a master's level course for students with strong design and
implementation skills who are likely to pursue careers as software architects
and lead engineers. It may be taken by well-prepared undergraduates
with excellent design and implementation skills in low-level systems
programming. The course assumes a high level of proficiency in all aspects
of operating system design and implementation. This course will help students
prepare for leadership roles in creating and evolving the complex, large-
scale computer systems that society will increasingly depend on in the
future. The course will teach the organizing principles of such systems,
identifying a core set of versatile techniques that are applicable across
many system layers. Students will acquire the knowledge base, intellectual
tools, hands-on skills and modes of thought needed to build well-engineered
computer systems that withstand the test of time, growth in scale, and
stresses of live use. Topics covered include: caching, prefetching, damage
containment, scale reduction, hints, replication, hash-based techniques, and
fragmentation reduction. A substantial project component is an integral
part of the course. A high level of proficiency in systems programming is
expected. Prerequisite: 15-410.

15-611 Compiler Design
Fall: 12 units
This course covers the design and implementation of compiler and run-time
systems for high-level languages, and examines the interaction between
language design, compiler design, and run-time organization. Topics covered
include syntactic and lexical analysis, handling of user-defined types and
type-checking, context analysis, code generation and optimization, and
memory management and run-time organization. Prerequisites: 15213 or
15312.

15-883 Computational Models of Neural Systems
All Semesters: 12 units
DESCRIPTION: This course is an in-depth study of information processing in real neural systems from a
computer science perspective. We will examine several brain areas, such as the hippocampus and cerebellum, where processing is sufficiently well
understood that it can be discussed in terms of specific representations and algorithms. We will focus primarily on computer models of these
systems, after establishing the necessary anatomical, physiological, and
psychophysical context. There will be some neuroscience tutorial lectures for those with no prior background in this area. (cp)<p>Please refer to the
<http://www.cs.cmu.edu/~csd-grad/courseschedule/fall11.html> for the most recent schedule updates.</p>

Design Courses

51-101 Design Studio I
Fall: 9 units
This studio course introduces students to the fundamentals of two- and
three-dimensional design. Through a wide range of exercises and projects students explore what it means to communicate with form and images.
The course covers the use of visual and physical elements in design, with emphasis placed on idea and form development, visual organization, construction, understanding materials, and considering how people draw meaning from form. This course is for undergraduate design majors only.

51-102 Design Studio II
Spring: 9 units
This course is designed to provide a series of experiences that prepare
students for a major in Industrial or Communication Design. Through the
exploration of form and content, students begin to develop their abilities to
design in more complex situations. This course seeks to develop perceptual
and expressive abilities that allow for thorough interpretation of design
problems. Students work as individuals and as members of teams to
develop an understanding of design process. Student evaluation is based
on faculty critique of projects at different stages of development in a studio
setting, with the participation of students. This course is for undergraduate
design majors only. Prerequisites: 51101. Prerequisite: 51-101.

51-103 Design Workshop
Fall: 3 units
Design Workshop is a special course created for first year design students
and serves as a supplement to primary studio and elective courses. In this
course, students will explore design activities related to their core studio
courses, receive special skills training, engage with guest lecturers, and
attend field trips. Each class meets once per week.

51-104 Design Workshop II
Spring: 3 units
Design Workshop is a special course created for first year design students
and serves as a supplement to primary studio and elective courses. In this
course, students will explore design activities related to their core studio
courses, receive special skills training, engage with guest lecturers, and
attend field trips. Each class meets once per week.

51-121 Design Drawing I
Fall: 9 units
Drawing is an essential tool that designers use to communicate, develop,
and test their ideas. This basic drawing course is designed to introduce
students to a variety of drawing approaches related to the design process.
Students learn methods of representation, communication, idea generation,
and form development. A sequential approach to the understanding of
structure, form, space and the effects of light through the use of line, tone and texture are emphasized. Students are introduced to a variety of
simple drawing media. Drawing in this context is viewed as a means of
design thinking, with emphasis placed on the analysis and interpretation
of existing man-made and organic forms. Demonstrations, group and
individual critiques augment concepts presented in class. This course is for
undergraduate design majors only.

51-122 Design Drawing II
Spring: 9 units
This course introduces drawing systems and diagrammatic conventions
while further developing the principles covered in Design Drawing I.
Exploration, analysis, refinement and communication of design concepts are the main issues covered in this course. Perspective systems and
diagramming are used to understand, communicate and express various
forms of information. Projects reinforce freehand sketching and provide the basis for introduction to more complex drawing media. Demonstrations, group and individual critiques reinforce concepts presented in class.
This course is for undergraduate design majors only. Prerequisites: 51121
Prerequisite: 51-121.

51-132 Introduction to Photo Design
Spring: 4.5 units
Using a digital camera, students learn how to extend their ‘seeing’ with
the camera, both in the world and in a shooting studio. Through shooting
assignments students will understand how to: deconstruct image meaning and
aesthetical choices, construction of photographic meaning and
aesthetics, an understanding of color and how color delivers meaning,
how a photographic studio works, proper digital photographic workflow and
contemporary trends in photography. Intended for Design Majors, or
permission of the instructor. Prerequisite: 51-101.

51-134 Photo Design II
Spring: 4.5 units
A continuation of Introduction to Photo Design Prerequisites: Introduction to
Photo Design; 51-132.

51-171 Human Experience in Design
Fall: 9 units
This course introduces the central theme of design and the design
professions: the importance of human beings in all aspects of design
thinking and practice. We begin by exploring design and the human
dimension, discussing the nature of human beings and their physical,
psychological, and spiritual or cultural needs. Then, we consider the role of
human beings in the design process, exploring how designers respond to
human needs and issues of value. Finally, we discuss the scope of design in
our personal, social, and cultural environment, observing how thoroughly
design has permeated our lives through images, physical objects, services,
and environmental systems, extending even to a profound impact on the
ecological system of the planet. This course includes lectures, discussions,
and written assignments, with readings and extensive visual materials.
Required for all design majors.
51-201 CD I: Basic Type  
Fall: 9 units  
This is the first studio for students in the communication design program. Students explore the fundamental principles of typography, where type is regarded as an image that serves a variety of communicative purposes. Projects allow students to explore issues of form and meaning, hierarchy, legibility and readability, structure and composition, and the design process. While typography is a highly focused branch of communication design, this introduction to typography and context serves to open a path for students to study all facets of communication design in subsequent courses. Students use traditional and contemporary design materials and tools to communicate ideas visually. Special tutorials provide basic instruction in software such as InDesign and Adobe Illustrator. Key figures, philosophies, and technologies that have shaped typography are discussed throughout the course in context. The course also includes a demonstration of letterpress operation in the School’s Lab Press and a guided visit to the Hunt Library’s Rare Book Room. This course is for undergraduate Communication Design majors only.  
Prerequisites: 51102  
Prerequisite: 51-102.

51-202 Type II: Organizing Information  
Spring: 9 units  
In this course students participate in a range of exercises, projects, discussions, and readings that are geared towards deepening their understanding of communication design and improving their skills. Course activities require students to consider and propose ways to inform, convince, question, and engage their audiences by clarifying and organizing information. Students deconstruct existing pieces of communication design, studying how their composition, type and image usage, and hierarchy reflects the content being communicated and the order in which it is read. Working in print and digital media, students study the similarities and differences among mediums and explore methods for effectively communicating information in each area. Students analyze design examples from the perspective of the maker and the receiver(s). This facilitates discussions that focus on the role of the designer in the communication of information (Should a designer’s voice be evident?) and the need for user-centered design solutions. This course is for undergraduate Communication Design majors only.  
Prerequisite: 51-201.

51-203 Communication Design Computer Lab  
Fall: 3 units  
This sophomore level Communication Design course introduces students to various software that designers use when creating communication pieces. Software is introduced in a way that coincides with the Basic Typography assignments, providing students with best practices that help them work efficiently and effectively. CD majors only, or permission of the instructor.  
Corequisites: 51-201.

51-211 Generation of Form: Industrial Design I  
Fall: 9 units  
Generation of Form is the first studio for students in the industrial design program. Students explore product aesthetics and basic formal issues as they pertain to industrial design. This course integrates the principles of three dimensional design, drawing and prototyping as they apply to the generation of product form. Emphasis is placed on issues that dictate the form of products and their creation. Students develop basic prototyping, conceptual drawing, and presentation skills for the purpose of exploring, analyzing, refining and communicating design concepts. Required of ID students; lab fee. Due to space constraints, this course is only offered to undergraduate Industrial Design majors.  
Prerequisite: 51-101.

51-212 Meaning of Form: ID Studio II  
Spring: 9 units  
This studio course introduces students to the functional and expressive meaning of product form through creative exploration and design-making. Functional product attributes include those that guide intuitive, safe, and comfortable use; expressive attributes include aesthetic, cultural, and contextual variables. Students are exposed to various methods of conceptual sketching, prototyping, and documentation to realize and communicate ideas in a process that anticipates human interpretation and response to design. Lab fee applies. This course is restricted to undergraduate Industrial Design majors only.  
Prerequisite: 51-211.

51-222 Decoding Place  
Spring: 9 units  
This course will explore ways to decode, see, think and interpret the visual language of ‘place’. Through the intersection of found symbols, signs, images and color we will bring to light the function and purpose of our surroundings, and how they speak to natural and the built environment. During the course we will investigate the following question; How do we design visual systems which are understood by everyone, regardless of their language or culture but also work in harmony with natural systems? Students will work with traditional materials and tools as well as computers to understand the strengths and limitations of each, comparing their similarities and differences in the context of theoretical and applied projects. This course is for Communication Design majors only, or by permission of the instructor.  
Prerequisites: 51-201 or 51-211.

51-224 Preparing for Pixels & Prints  
Spring: 9 units  
This is a lecture/lab that explores the processes and materials of the printing industry, followed by a dynamic, hands-on introduction to designing for the web. The first half of the course focuses on best practices in preparing digital files for printing and the various processes involved in applying ink to paper. Students are introduced to the affordances and limitations of printing processes and are shown how to properly prepare files with printing constraints in mind. The second half focuses on core skills in designing for the web, including basic instruction to HTML and CSS. Students investigate the technological limitations of the web and learn how to design within its constraints. Students are also introduced to HTML, CSS, and concepts of designing for divergent platforms including mobile phones, tablets and desktops. This course is for undergraduate Communication Design majors only.  
Prerequisite: 51-201.

51-227 Marks, Signs and Communications  
Intermittent: 9 units  
In this studio course you will design a variety of marks ranging from trademarks, (logos), logotypes, icons, wayfinding devices and potential symbols. You will be exposed to many examples of marks for reference, acquire an understanding of the design process and develop the confidence of how marks fit into a communication strategy. This course is for undergraduate Design majors only, or by permission of the instructor.  

51-229 Digital Photographic Imaging  
Fall: 9 units  
The objective of this course is to provide students with a practical, technical and theoretical foundation in digital imaging. The primary software for this course is Adobe Photoshop, with which students will explore construction, combination, manipulation, input, and output of digital files for printing and the various processes involved in applying ink to paper. Students are introduced to the affordances and limitations of printing processes and are shown how to properly prepare files with printing constraints in mind. The second half focuses on core skills in designing for the web, including basic instruction to HTML and CSS. Students investigate the technological limitations of the web and learn how to design within its constraints. Students are also introduced to HTML, CSS, and concepts of designing for divergent platforms including mobile phones, tablets and desktops. This course is for undergraduate Communication Design majors only, or by permission of the instructor.  

51-231 Calligraphy I  
All Semesters: 9 units  
Working with pure unadorned Roman letterforms, this course introduces students to the theory and practice of hand-generated letters, employing a variety of mark-making tools. This course provides an in-depth understanding of the basic principles and techniques of the art of formal writing. Rhythm, texture and composition are achieved through routine, elementary exercises using geometric forms, demanding concentration and manual discipline with the development of hand-eye coordination. The function, use, and harmonious sequencing of letterforms is taught through weekly projects. Awareness of rhythm, texture and letterform structure is achieved through routine exercises. Drills, demonstrations, discussions, individual and class critiques are ongoing. Additional related topics and activities introduced in class include books: binding and design. A brief introduction to the historical development of our Western alphabet is provided through film, slides, demonstrations, with discussion of twentieth century type designs. Students also gain exposure to letter vocabulary, paleography, monotypes, words and punctuation, classical page design, publication design—past and present, and calligraphy’s role in design today. Thinking with hands and eyes, the manual placement and spacing of letters practiced in this course awakens sensitivity and judgment in the designer.  

51-232 Calligraphy II  
All Semesters: 9 units  
This course serves as a continuation and deeper investigation of topics explored in Calligraphy I, where students tackle advanced problems in calligraphy and lettering. The introduction of new hands is to be decided by the student and instructor. Prerequisites: 51231  
Prerequisite: 51-231.
51-241 How People Work
Fall: 9 units
51241 How People Work: Human Factors (ID/CD Lab I) This course is a general introduction to the field of human-centered design and applied human factors. It centers on the understanding of physical, cognitive, and emotional human needs and desires, including methods employed to acquire this information and translate it into useful criteria for the design and evaluation of products. Lecture, discussion, lab exercises, and projects are employed. Required of all sophomore design students. Others admitted by permission of instructor only.

51-242 How Things Work: Mechanics and Electronics
Spring: 9 units
This course investigates the basic principles of mechanics and electronics. Through the combination of lectures, investigations, and lab experiments, students develop simplified representations of complex systems. The skills of freehand drawing, mechanical drawing and three-dimensional models are employed and developed during the project sequence. Required of ID students. Instructor permission required for non-ID majors. Prerequisite: 51-211.

51-243 Prototyping
Fall: 4.5 units
A half-semester laboratory mini-course introducing 3D modeling software. Each class meeting consists of an introduction to and demonstration of specific aspects and functions of SolidWorks software. At the end of each class session, work related to the covered topic(s) will be assigned for completion by the next class meeting. This course is a requirement for all ID majors. Instructor permission required for non-ID majors. Corequisites: 51-211.

51-246 Visual Communication Fundamentals
Spring: 4.5 units
This course teaches Industrial Design students basic lighting and camera techniques for documenting three dimensional design work digitally. Required for all ID students. Prerequisite: 51-211.

51-251 Digital Prototyping
Fall: 4.5 units
A half-semester laboratory mini-course introducing 3D modeling software. This course develops advanced skills in typography and communication design, including the study of type and motion. Students learn to conceptualize and visualize more complex bodies of information for a variety of communicative purposes. Projects encourage students to develop a deeper understanding of the expressive potential of type and image and to develop critical and creative thinking skills with which to assess the effectiveness of their own work and that of their peers. Course objectives are to encourage an active exchange of ideas and information which allow students to develop the ability to clearly articulate their ideas and thought processes in relation to their work. This leads to a more focused method for developing and expressing ideas effectively. Instructor permission required for non-ID majors. Prerequisites: 51-202.
51-302 Type IV: Designing with Systems  
Spring: 9 units  
As the final course in a sequence of typography courses for Communication Design majors, this one builds on everything learned previously. The course focuses on creating a system for dealing with large amounts of content, either self-generated or found, in print and digital platforms. The differences and similarities between traditional and new platforms of delivery provide students an understanding of where new forms of communication may be heading, given the rise in mobile devices that allow for downloading of content. Topics may include systems for the delivery of typographic, images, movies, music, sound, and motion, as well as screen design and navigation. This course is required of Communication Design majors in the School of Design. Prerequisite courses include Type III, Type II, and Type I.  
Prerequisites: 51301  
Prerequisite: 51-301.

51-311 Product Design ID III  
Fall: 9 units  
Course projects are chosen to give students an opportunity to use their creative, technical and theoretical skills in a business application. The primary emphasis is on the use of a systematic process for the design and development of products that are useful, usable, desirable and feasible. Attention is also given to designers’ interaction with engineering, marketing, and other professionals who influence the product development process. Studio, model shop tools and use of digital tools, such as 3D computer modeling, digital sketching, etc. required; lab fee. Instructor permission required for non-ID majors.  
Prerequisites: 51-212.

51-312 Products in Systems: ID IV  
Spring: 9 units  
This course introduces the themes of product planning and the development of products within systems and as systems. The projects are broad in scope and require students to develop products that reflect an understanding of the entire development cycle. Tools and skills for the studio and model shop are required; lab fee. Instructor permission required for non-ID majors.  
Prerequisites: 51-311.

51-316 Designing Spaces  
Intermittent: 4.5 units  
Stop. Look around you. Where are you and what are you doing? Are you in a lecture hall? A gallery? The check-out line at the “O”? How does the layout of the space support the activity that’s supposed to happen there? How big is the space, and how is it proportioned? If you added ten feet to the ceiling height, how would it change the way it feels? Look down at your feet. What material are you standing on? Does it feel soft beneath your feet? How does it affect the sound quality of the room? Imagine it as a bright orange surface. What if the walls were rough instead of smooth—how would it feel? What, in sum, does it feel like to be in this space and what are the fixtures like? What, in sum, does it feel like to be in this space and what are the elements that define it? This course will present you with the opportunity to consider some of these questions, and will allow you to look at spatial issues from your perspective as a designer. The semester will be divided into sections exploring issues such as program, site, structure, material, and light; and each section will be supported by a series of exercises, lectures, and short projects. Designing Spaces should be of particular interest to those interested in pursuing exhibit design, interior design, and wayfinding design, but it may also be useful simply as a way of expanding your design framework. This course is open to junior and senior ID and CD students, and has no prerequisites.

51-319 Digital Photography in the Real World  
Intermittent: 9 units  
Digital Photography in the Real World Photographers are active observers. They look until they see what they want others to see—then they compose and click the shutter. In this course students will walk streets with their cameras. They will learn how to use their cameras to better understand what they believe is important, beautiful, and/or intriguing in the world. They will also learn how to communicate their imagery to others through screen-based and print output. Assignments range from accurately describing reality, to showing aspects of life that should be improved, to making images for purely aesthetic reasons. There are two main goals to this course: learning the fundamentals of operating a digital camera and producing digital output; and, learning to become better ‘seers’ in the world. Students must own a camera but no prior photographic experience is necessary.

51-321 Photographic Narrative  
Intermittent: 9 units  
Most photographs tell stories. We see photographs in newspapers, magazines, snapshot albums, on the web, in books, and in posters. In these contexts photographs often work with words to convey meaning, whether they are shown with captions, news stories, or just with titles. Photographs can work without words, too, to create purely visual narratives. In this course, students will make a photo narrative and determine how it will be seen. Students may make photo books, for example, or decide that their images will be seen digitally on screen. While students are making photographs, we will explore the rich traditions of photographic story-telling that range from the world-oriented work of photo-journalist W. Eugene Smith to the documentarians such as Walker Evans, Nicholas Nixon, and Alec Soth. We will look at photographers, too, who construct fictional worlds, such as Duane Michals, Cindy Sherman, and Gregory Crewdson. As students make their own narratives, we will look at the interplay between words and photographic images; how images are paced and scaled to create rhythm; how photographs are sequenced to tell stories; and other formal elements involved in creating visual narratives. 12-15 students. Prerequisite—a college level photography course.  
Prerequisites: 51-221 and 51-222.

51-322 Graphic Identity  
Intermittent: 9 units  
Graphic Identity In this studio course we’ll evaluate how effective graphic identity programs convey the character and spirit of the organizations they represent. We’ll explore how successful identity programs invite expression throughout the organization, and across media. A series of rapid and intensive projects encompassing positioning, logo/symbol design, and innovative identity extension and expansion will give you first-hand experience with the creative — and diplomatic —challenges of designing effective.  
Prerequisite: 51-301.

51-323 Drawing and Communication  
Intermittent: 9 units  
This course explores drawing as a means of communicating and expressing ideas. We will explore drawing by hand, but there will be some integration of other imaging technologies. Themes will center around objects, people, and places in various contexts. Emphasis is placed on individual interpretation and exploration of the assigned projects. Each project has several components that cause the student to generate and develop ideas as they work towards more refined images. Specific conceptual and technical skills will be discussed both individually and in groups as students examine the relationship between images and meaning. Instructor permission required for non-Design majors.  
Prerequisites: 51-221 and 51-222.

51-324 Basic Prototyping  
Spring: 4.5 units  
A half-semester laboratory mini-course introducing a range of materials, methods, and workshop techniques by which designers prototype designs in three dimensions. Basic competence in shop techniques is established by bringing to realization a series of simple artifacts. Studio and model shop tools are required; lab fee. Instructor permission required for non-CD majors.  
Prerequisites: 51-201.

51-325 Signs/Symbols/Marks  
Intermittent: 9 units  
This course focuses on the formal development of pictorial signs (icons, symbols, marks, etc.) either as individual elements or as families and systems of compatible forms. Through a variety of projects, students will employ an analytical process, which includes research, observation, idea generation, development, selection, and refinement of images. We will explore the personal, social, and cultural messages that such images carry. There will be applications in two- and three-dimensional formats. Instructor permission required for non-Design majors.  
Prerequisite: 51-202.
51-326 Photography & Family
Intermittent: 9 units
Picturing Families at Sojourner’s House In this course we will partner with Sojourner’s House to tell photo-based stories of the residents. Sojourner’s House (SH), located in East Liberty, is a home for women and families who have faced obstacles of addiction and homelessness. Those at SH have lived through hard times. The women, some of whom are mothers, are now ‘clean and sober’ but before they came to SH, they were addicts who lived strained lives. As a class we will be working with women and families who are creating positive change in their lives through Sojourner’s House supportive environment. Students, working in pairs, will team with individuals or families. Through weekly sessions, students will explore how the camera can be used to tell a range of different stories, which may range from a traditional photo documentary, to a narrative that is ‘directed’ by a student with photographs made by Sojourner’s House residents. Students may work with children to show their day-to-day life; they may work with an individual woman to tell the story of her dreams; or they may choose to work with staff at Sojourner’s House to explore why someone goes into this line of work, to name a range of examples. Students will learn how to sensitively work with people who have experienced extreme difficulty while they are learning about addiction through readings and first hand accounts. While they are getting to know their subjects, students will explore the various ways to create an in-depth photo narrative. Most important, students will learn how the camera can be used to create connections and trust between people. Prerequisite: A college level photography course 12 students — sophomores to grads Familiarity with digital photography.

51-327 Introduction to Web Design
Fall: 9 units
This class will introduce the basics of designing and building websites, as well as the fundamentals of HTML5 and CSS3, to assist students in creating semantically sound web pages that can be viewed across a variety of platforms, devices and browsers. The class will help students understand the constraints and advantages of working with the web as compared to traditional print media. Students will also be introduced to content management systems and the web design process. Upon completion, students will be capable of designing, creating, and launching their own web sites. Your own laptop is required, with the following software installed: Adobe CS 5 or later. This course is for Design Majors only, or by special permission of the instructor.

51-328 Advanced Web Design
Intermittent: 9 units
Advanced Web Design builds off of the fundamentals of Introduction to Web Design to make students more sophisticated web designers. Focusing on furthering skills through HTML5 and CSS3, this course will also delve more deeply into web research and strategy, content development and search engine optimization and introduce the basics of PHP and Javascript. Students will also gain a basic understanding of databases, work with content management systems, and design and develop for divergent platforms such as phones, tablets, and desktop computers. Students will develop advanced websites while mastering HTML5 and CSS3, as well as gain exposure to scripting and PHP. Intro to Web Design (51327) is a prerequisite for this course. Prerequisites: 51327
Prerequisite: 51-327

51-330 Photo Book Design
Intermittent: 9 units
The Photo Book Photographs are often made into books. In this course, students will make photographs with the intention of presenting them as a book. We will deal with theme and content, image sequence and size, and the use of text with image. In addition to making their own, students will look at historical and contemporary photo books to see how the rich tradition of photo book has evolved through time and continues today. For Communication Design majors, or by the permission of the instructor. Extensive shooting and darkroom work, library research. Prerequisite: college level photography course.

51-331 Advanced Calligraphy I
All Semesters: 9 units
This course serves a continuation of study in the discipline of calligraphy. (It meets at the same time as Calligraphy II.) Students may take one of two directions in the course. (1) Enlarging their repertoire of scripts, contemporary or traditional, for use in limited areas of work such as book or display work, or (2) Concentrating on more intensive problem solving using a limited repertoire of scripts such as Roman, Italic, Sans Serif. Prerequisites: 51232
Prerequisite: 51-232.

51-332 Advanced Calligraphy II
All Semesters: 9 units
This course serves a continuation of study in the discipline of calligraphy. (It meets at the same time as Calligraphy I.) Students are encouraged to tackle advanced problems with the instructor to determine new directions of study. Prerequisites: 51331
Prerequisite: 51-331.

51-333 Poster Design
Intermittent: 9 units

51-334 Type and the Package
Intermittent: 9 units
The package is a unique structure designed to protect a product from its point of manufacture to the point of purchase. Its product semantics are intended to provide a sense of its contents through its design as well as through the messages on the packaging surfaces, (ie package and/or box). This course will explore the package from its structural design/product semantics as well as the typographic messages used to communicate the product to the buyer/user. We will begin with some more fundamental products and concentrate on the product messages contained on them, their typographic and message representations on the packages. Here are some of the issues we will explore: type and its fit to branding, typography appropriateness, levels of simple to complex instructions on products, and effective typography for crowded shelf spaces. We will explore the typographic hierarchy of information on the package, play with the principle of "less type is more" and examine size levels of type on a package, and if there is time, there are still more explorations. The intent is to examine the effective role of typography in packaging. We will work with some established products as well as the potential of designing a package and its typographic content from the the ground up. Instructor permission required for non-Design majors. Limit to 10 students: (because of the 2 hour class structure). I would like 5 CD and 5 ID students if possible as an ideal mix. Prerequisites: 51-301 or 51-311.

51-335 Mapping and Diagramming
Fall: 9 units
This course explores the different ways in which we communicate complex information, through maps and diagrams. Students will design maps and diagrams using subject matter of their choice. Instructor permission required for non-Design majors. Prerequisite: 51-301.

51-337 Letterpress in a Digital World
Intermittent: 9 units
What value does the antiquated process of letterpress printing have in our current digital world? What can we learn from the process that was used as the primary format of reproducing the word for nearly 500 years? As designers and artists, we have the opportunity to re-examine an obsolete mode of commercial printing, and explore how these techniques and technologies can add to our experience, expand our repertoire, and invigorate our working process. Our goal in this course is to seek out new opportunities in expression, resulting from the harmonious merger of new and old technologies. Intended for design juniors and seniors.

51-338 Documentary Photography
Intermittent: 9 units
Documentary Photography: The Social and Built Landscape Documentary photography explores issues, often social, humanistic and/or political, in man-made culture. This course examines the work of nineteenth, twentieth, and twenty-first century documentarians while students photographically investigate their own topics. Among the many ethical areas of a documentarian’s concern, the course examines (through looking at the documentary tradition and through the student’s own work) the following: the photographer’s relationship to the subject; the choices involved in representing the subject; the act of selectivity in framing the subject; the reasons for making documentary photographs; the intended audience for documentary photography; and the appropriate final display of the photographs? Extensive shooting, printing, and library research. Prerequisite: A beginning photography course, or by the permission of the instructor.

51-341 How Things are Made
Fall: 9 units
How Things Are Made This course will provide a breadth of knowledge for current manufacturing, materials, and processes encountered in the industrial design field. There will be an emphasis on actual production/ manufacture methods and not rapid prototyping methods. The class will consist of various lectures, media, electronic tools, and on-site visits to enable an understanding of how mass production affects design and design decisions. Industrial Design juniors or permission of the instructor.
51-342 Projects in Human-Centered Design  
Spring: 9 units  
This course presents an opportunity to experience and understand the human centered research and design process through a self-defined project. Projects follow a common sequence of exploratory human and product research, concept generation using participatory and co-design methods, and user feedback to evaluate emerging design concepts, as they are refined. Course format includes lecture, discussion, lab exercises, interim presentations, a final presentation and thorough documentation of the research and design process. Open to all juniors and seniors in Design. All others will be waitlisted and admitted by permission of the instructor.

51-343 Digitech Design Tools  
Fall: 9 units  
This course is the application and experimentation of digital technology inputs and outputs. The purpose will be to design, build, and experiment with forms that are unique to computer controlled rapid prototyping. The combination of 2-D and 3-dimensional computer modeling and the dFab Lab facilities’ rapid prototyping equipment will provide the means and method for output and project work. This course is a Studio and Lab course structure. PreRequisites: 3D solid modeling or 3D surface modeling experience REQUIRED. This course is intended for junior and senior Industrial Design majors, or by permission of the instructor. Prerequisites: 51251 or 51344  
51-342 Projects in Human-Centered Design  
Prerequisites: 51-243 or 51-324.

51-344 Advanced Digital Prototyping  
Spring: 6 units  
This course is an advanced course using SolidWorks computer modeling. It is a prerequisite for Production Prototyping. Prerequisite: 51-211.

51-345 Pragmatics of Color for Non-CD Majors  
Intermittent: 9 units  
Pragmatics of Color for non-CD majors Throughout the course, we will explore the application of color and its’ use through many different medium, products and environments. We will use a variety of source materials like pigment, colored paper, and photography. These exercises will help us to explore how the different medium affect color perception. Because color is extremely dynamic and interactive, a good deal of emphasis will be placed on your ability to iterate many variations so that comparison becomes the point of discussion and learning. Equally important, is increasing your sensitivity to the nuances of color through direct observation and experimentation. The class exercises are distinctly different in nature from one to the next; they are organized in order to build upon each other. Prerequisites: you must own a digital camera and have previous experience with Photoshop and Illustrator.

51-346 Production Prototyping  
Spring: 6 units  
This course is the 2nd half of Advanced Digital Prototyping, using your work in SolidWorks to produce hard models. Prerequisite: 51-311.

51-347 Drawing from Nature  
Intermittent: 9 units  
Drawing From Nature This course is about observing and making images of things growing, crawling, flying, swimming etc. Observations will be made firsthand in the field, supported with relevant research in topic areas with the aim of deepening personal understanding of all things biological. Issues surrounding natural forms such as behavior, locomotion, adaptation, the environment and systems will also be investigated. We will work in tandem on refining our abilities in communicating what we discover through the process of drawing. A variety of visualization methods will be covered i.e. analytical drawing, visual notes, and diagramming to name a few. We will be using a variety of basic drawing and digital media to develop our work as we uncover aspects of form, structure and surface. Guest speakers will present work they have done in areas such as botany, biology, and environmental studies to name a few. A majority of the work will be done in the field and will then be developed in the studio. A final project will be assigned that will challenge you to develop a concept along with a compelling form(s) that communicates what you have uncovered about nature to a variety of audiences. This course builds on your experiences from First Year drawing and introduces several more advanced visualization methods. This course is intended for Junior and Senior Design Majors.

51-349 Visual Notation/Journaling  
Intermittent: 9 units  
Visual Notation Visual notation is the graphic equivalent of taking written notes. While the camera is a valuable and at times indispensable tool for recording what we see, however, the camera cannot make visible mental concepts. Nor can it discover and display underlying structures, create hierarchies, explain organizational schema or concepts that are not easily seen or understood. This course is about making visual notes in order to become fluent in our abilities to observe, record and integrate. Through daily entries in a journal students will work in several content areas i.e. mapping, natural and built environments and systems to name a few. A good portion of the work in this class we be conducted in the field using the resources available to us such as the museum, zoo and architectural sites. You will also be challenged to incorporate your notes as tools for communicating design concepts, implementing project development and presentations. The course will rely on the use of a variety of simple drawing tools and electronic media. Several visualization methods will be introduced and the work will build on the drawing experiences from First Year drawing. This course is intended for Junior and Senior Design Majors.

51-351 Drawing, Expression and Communication  
Intermittent: 4.5 units  
Drawing, Expression and Communication This course explores the use of drawing as a means of visualizing, communicating and expressing form, space and ideas and as such is seen as a fundamental activity used to develop visual thought in the design process. Weekly themes will be introduced, along with presentation and accompanying questions that require responses through the generation and development of work done primarily through freehand drawing. Specific conceptual and technical skills will be discussed both individually and in groups with emphasis placed on individual interpretation and exploration of the assignments with the goal of developing visual fluency. A part of the course will be spent looking at how designers have used drawing in the design process at various times through history and within a variety of contexts. Emphasis is placed on craftsmanship and more on the role drawing may play in the complex process of visual thinking and notation. Consistent with the credits allocated to this course a total of 5 hours of work, both in and outside of class, will be expected each week. A portfolio of work will be expected the last day of class. Instructor permission required for non-Design majors.

51-352 Writing & Photography: Magazine Writing & Journalism  
Intermittent: 4 units  
Revealing Place: Photographers and Writers Working Together Writers and photographers have worked together throughout the 20'th and into the 21'st century to produce powerful documents. We are interested in how photographers have worked together throughout the 20’th and into the 21’st century to produce powerful documents. We are interested in how photographs and words describe people and places, and the dialogue that happens when words and images come together. Students will work individually and in teams, doing field research in the community as photographers and writers. Students will respond to a variety of short assignments along with a semester-long project. Course is open to Design and English juniors, seniors and grad students by instructor’s permission.

51-355 Experimental Sketching  
Intermittent: 4.5 units  
Experimental Forms of Sketching fall 2011 Advancing design drawing philosophy and application This 7 week mini course seeks to expand our experiences with interpreting forms of drawing quality within the process of sketching. This approach will explore semantics of rendering with mixed media, sensitivity of representational perspective, form building, and sequence evolution, within drawing developments that stimulate emotional connections with a viewer. Through exploring and manipulating variables, we will use the nature of drawing behavior processes to expand the interpretive significance of abstract idea forms. These “drawing idea forms” will be represented throughout a range of abstract levels from literal to highly figurative. Interpretations will derive from a variety of themes involving design, life, and nature and expressed on paper as objects, scenes, and story persuasions.
51-359 Prototyping Tools for Embodying UX Design  
Intermittent: 9 units  
The course intent is to develop appropriate user experience of tools and technology for a projected time frame or context of use. The need to understand people’s stories, their lives, and how they want to live determines what interfaces, products, and systems should be developed. Student teams will work together to create appropriate user interactions and experiences which are supported by the design of tools and/or technology. This integrated course will utilize rapid prototyping as the basis for the creation of these proposed tools and products. This course is intended for junior, senior, graduate level students, Non-Disclosure Agreement and other legal agreements may be part of the requirements. Proficiency in one or more of these visualization methods: freehand sketching, computer visualization in 2D graphics, motion graphics and/or 3D solid or surface modeling. By Instructor Approval if NOT in Design. Please forward statement of intent to Instructor.

51-371 Design & Social Change  
Intermittent: 6 units  
Social change can be described as any event or action that affects a group of individuals that have shared values or characteristics. It could also include acts of advocacy for the cause of changing society in a normative way (subjective). Through reading, writing, discussion and projects, this course will touch on a variety of current issues such as diversity, sustainability, accessibility. Students will apply design thinking to social issues, and learn to incorporate these considerations into their design process. Because this course only meets once a week, attendance and participation is a vital part of this course. This course is intended for Design juniors. Design Minors who have completed Design Fundamentals will also be considered.

51-374 Understanding Perception through Design  
Intermittent: 9 units  
Understanding Perception Through Design 51-374/51774 This course emphasizes audience expectations, also known as schemas, as a major influence on the artifacts we produce. For example, we read marble Corinthian columns as an entrance to a courtroom rather than to a home. The manner we use to communicate, either following or deviating from expectations, affects the way people perceive and process the information we present. Through lectures, discussions, readings, and projects, we will study the use of schemas in both print and digital mediums. We will also explore the bearing of expectations on the types of interactions and experiences we produce, answering the question: Can information become concrete and experiential versus abstract and readerly? Instructor permission required for non-Design majors. Prerequisites: 51-301 or 51-311.

51-375 Meaning in Images  
Intermittent: 9 units  
Images abound in our culture. This course takes a critical look at many different kinds of photographic images to understand how they operate in our culture to inform, persuade, and entertain various audiences. The content for this course will be generated from looking at, thinking about and discussing issues discovered while studying well-known to lesser-known images that range from photographs used in ad campaigns, to photographs that are used in scientific representation, to snapshots in family photo albums, to photographs that are used to show social injustices, to photographs that exist in museum collections. Readings will be assigned and short writing exercises will be required throughout the semester. In addition, photography assignments will be given. Design majors will have preference. Requirement: a digital camera. 15 students, junior and senior Design Majors.

51-376 Topics: Semantics & Aesthetics  
Intermittent: 9 units  
51376 (undergrads) 51876 (grads) Aesthetics & Design The course will explore the principles of visual composition, proportioning systems and the rules of order as it relates to art, architecture and design. The class will involve extensive reading and discussion of these topics in class. Some project work will also be required but minimal to the reading. A reading list will be provided. Instructor permission required for non-Design majors.

51-378 History of the Book and Printing  
Intermittent: 6 units  
History of Books and Printing 51378 A survey of the materials and techniques used to make books covering manuscripts, calligraphy, printing, presses, type design, readers, illustrators, graphic techniques, and even e-books examined using a variety of tools: real rare books, readings, discussion, in-class exercises, essays & quizzes.

51-379 Information + Interaction + Perception  
Intermittent: 9 units  
As a society, we’re inundated with enormous amounts of dense information on a daily basis. In fact, many of us have grown so accustomed to the abundance of information in our lives that we expect and need it to be accessible virtually anywhere and anytime. Technological advancements, which seem to develop at lightning speed, continuously provide us with tools that make it easy for us to access information quickly. However, little is being done to aid people’s understanding of information that is increasing in complexity. Why? Our addiction to accessible and thorough information has caused many of us to turn a blind eye to the perceptual problems associated with its speedy delivery. In this course we will investigate contemporary visualizations of information and the bearing of their forms on the quality of communication. We will also study how people’s perception of content, interaction with others, belief systems, and mental and physical well being can be affected by the visual communication of information. Thus, although we CAN represent information various ways we will ask how SHOULD it be designed to aid people’s understanding of it. Your explorations will take the form of analyses of existing artifacts; class discussions and exercises; short, relevant readings that originate in various disciplines such as cognitive science, architecture, learning science, and design; and corresponding projects that enable you to illustrate what you’re learning.

51-380 Selected Topics on Rhetoric & Information Design  
Intermittent: 9 units  
Selected Topics on Rhetoric and Information Design The role of Information design in our society has become increasingly important, as people desire to restore their sense of control within the environment of information overload and growing complexity. At the same time, the development of digital technology and media convergence calls for the need to consider how complex factors can jointly work as one system and how they could be presented flexibly for dynamic in particular situations. Now we have to consider the characteristics of different screens where the information will be displayed, different users in diverse situations, changing environment of use, and different information products working together and with physical artifacts in relationship. This is in addition to the clear communication needed in each situation. These conditions call for necessity for a high level thinking that can support designers to make connection between each particular situation in a holistic context. The readings and projects in this course will provide students with opportunity to explore how rhetoric can provide systematic frameworks for designing information products in complex situations. Information design has a lot in common with rhetoric in that both are intended to create effective communication in a given situation. Both see audience as active participants, not passive recipients. Both are concerned with the style of elements to some extent, but from a broader perspective their primary objectives lie in the creation of persuasive arguments. In this sense, information design can be understood as a way to communicate information to an audience in various rhetorical situations, where the purpose is not only to instruct or to persuade the audience, but also to support their individual decision-making and collective action.

51-382 Design for Happiness  
Intermittent: 9 units  
This seminar course will examine the aesthetic, political, economic, technological, social, and cultural context of design from the mid-1930s to the mid-1960s through critical reading of primary and secondary sources. Seminar topics will include the ‘Good Design’ movement as fostered by American museums and department stores, the Cold War’s impact on visual culture, analysis of television as new media, the internationalization of business, conformity and suburbanization, the Civil rights and Women’s rights movements’ impact on advertising, the consultant designer as celebrity through writings by and about them, and contemporary retro styles based on mid-century design. The course will culminate in a final research paper to be presented in class. Students should be familiar with critical approaches to reading and writing about design.
51-383 Topics: Conceptual Models  
Intermittent: 9 units  
As design problems become more complex, conceptual modeling becomes critical in design process, especially when designing for the abstract concepts such as interaction, experience, service, and systems. Creating conceptual models are often an important step for making the creative leap from user research findings to design implications, which is one of the core challenges in design process. Conceptual models are also effective tool to bring in shared understanding for different stakeholders in teams with multidisciplinary team members, user-participants, and clients. Moreover, these conceptual models often directly lead to final information products to support users to learn how to use complex systems. Conceptual Models is a full semester course that provides students with the opportunity to explore theories related to conceptual models and to improve skills in using them as a means of design. Being primarily developed for graduate and undergraduate students in Design, this course consists of two parts. The seminar part of the course will provide students with readings, examples, and in-class discussions to help them understand the nature of conceptual models. The project part of the course will provide an opportunity to apply these theories to actual projects. Students will work in individuals and teams to create conceptual models for different needs and goals in design process.

51-384 Revealing Place  
Intermittent: 4.5 units  
Revealing Place is a documentary photography class where students will use their cameras to explore a group, idea, and/or location and tell its story. Students will use photography as a way to engage community, document social phenomenon, and define what’s happening at that moment in the history of their chosen setting.

51-385 Design for Service  
Intermittent: 9 units  
Designing for Service is a full semester course to provide students with the opportunity to explore the philosophical ground of service design as well as the opportunity to practice embodying its perspectives, models, and theories to project process. Being primarily designed for graduate and undergraduate design students, this course consists of two parts. During the first part of the semester, students will be provided with readings from diverse related fields and asked to participate in discussions in order to gain a deep understanding of the nature of service, the methods used for service design, the nature of human experience when they interact with service products, and diverse perspectives on the products of service to broaden their understanding on the role of designers in our society and culture. During the later part of the semester, students will be asked to work on 2 service design projects in teams.

51-387 Information and Interaction  
Intermittent: 4.5 units  
Despite recent technological advancements, the representations of dense bodies of information still overwhelm viewers by requiring them to spend lots of time and energy deciphering content, while providing them little feedback on their accomplishments. Designers often give viewers a few options for organizing information. However, the content frequently remains fixed, enabling little input from viewers. In this class we will investigate the use of visuals, sound, and motion as tools for representing information that engages viewers in enjoyable, participatory processes of exploration and discovery. Throughout the mini we will explore dynamic information design from the viewer’s perspective by discussing their desires and expectations. We will explore strategies for developing appropriate representations of content, the value of patterns to deciphering the meaning of information, the importance and structure of entry points, and the role of interaction in setting the stage for fulfilling experiences. Instructor permission required for non-Design majors.

51-392 Images and Communication  
Intermittent: 4.5 units  
No one doubts the value of photography as a means of recording life. Even if we don't think of ourselves as photographers, digital cameras make it easy to photograph our families, our trips, and aspects of our life that we want to remember. But beyond snapshots, can photography also teach us how to see? And how do they teach us about the world? And, what are the qualities inherent in photographs that make them effective as artifacts of communication? Does looking through the camera’s viewfinder sensitize us to world and help us see more? Or, as some writers suggest, does the camera interfere with experiencing the world fully. This course explores seeing with the camera and the many issues that arise when one snaps the shutter. We will be looking at a range of different kinds of photographic images, understanding their contexts, and how to read them. Designers and other visual people use photographs extensively in their work. This course endeavors to make students more aware of their decisions and actions when making photographs as well as how to judge a photograph’s effectiveness. The issues that we discuss using photographs, relate to other kinds of visual images, as well. We will be making photographs as we are discussing critical issues in photography that come out of readings. Students must own a digital camera but no prior photographic experience is necessary.

51-394 Communicating with Images: Beyond the Snapshot  
Intermittent: 4.5 units  
Applied Research Methods is a lecture course that explores a range of research methods from traditional behavioral research to contemporary methods in use today. The goal of the course is to understand the process that the designer employs to understand the ‘say, do, undo’, responses of the user in order to develop appropriate solutions. We will look at a variety of methods for gathering qualitative information that inform the concept stages of the design process such as questionnaires, interviews, observations, trace measures, action research/participatory research methods. Starting out with simple exercises, we will progress to multi-method approaches for tackling more complex design problems.

51-396 Design Ethos & Action  
Intermittent: 9 units  
Increasingly, designers have the potential to operate as agents of change in a broad range of areas including corporate, government, non-profit, social innovation start-ups, and sustainability projects. With so much choice on the horizon, some designers may wonder, “What value do I bring to the world through design?” Values often are implicit and may vary across contexts (e.g., profit, efficiency, effectiveness, fairness, social impact, environmental impact). This course focuses on exploring and identifying the potential for positive and negative impact that design can have in the world around us.

51-398 Methodology of Visualization  
Intermittent: 4.5 units  
For ID and CD students who have taken First Year drawing Limit 12 students This mini-course will focus on field sketching, notation and rapid visualization in context. Over the course of 7 weeks, students will use various field excursions, exercises, and projects to develop competencies in perspective drawing, visual narratives, basic rendering, and figure drawing. The subject matter will vary, yet all lead towards generating communicative drawn artifacts. The primary project for this course will be a filled sketchbook.

51-399 Junior Independent Study  
All Semesters  
Guidelines for independent study in the Design office. Proposals must be approved by faculty before registration.

51-401 Senior Design Lab  
Fall: 12 units  
The fall semester senior year focuses on design agility and helping students develop new ways of addressing the complexity of design problems. Through a series of three independent labs, students explore three kinds of designerly behaviors — wondering, playing, and speaking. These behaviors are not methods to be learned; they are ways of being agile as a designer that frees and empowers you to be both creative and responsive to the situations in which you are working. These labs serve as the requisite precursor to the Spring capstone project. This course is reserved for senior Design majors only.
51-403 Independent Senior Project
Fall: 12 units
The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients.

51-404 Senior Project I
Spring: 12 units
The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients.

51-405 Senior Project: Communication Design
Fall: 12 units
The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project varies from one semester to the next, providing various opportunities in areas such as exhibit design, branding, and web design.

51-406 Senior Project: Communication Design
Spring: 12 units
This is the spring offering of 51-405.

51-407 Senior Project: Social Impact by Design
Fall: 12 units
The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project focuses on new product development.

51-408 Senior Project: Environmental Design
Spring: 12 units
This is the spring offering of 51-407.

51-409 Senior Project: Environmental Design
Fall: 12 units
The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project involves the design of a space, both indoors and outdoors, navigation of the space, and use of the space. Projects could include signage, exhibit design, navigation and wayfinding, furnishings within a space, or even park design.

51-410 Senior Project III (IPD)
Spring: 12 units
This course provides an integrated perspective on the many processes by which new products are designed, manufactured, and marketed. Under the direction of faculty from Design, Engineering, and Industrial Administration, students will work together in interdisciplinary groups on the development of real products. In addition to the product development project, the course includes lectures on innovation strategy, opportunity identification, designing products, object representation and manufacturability rules, computer-assisted design and prototyping, concept testing and protocol analysis, redesign issues, market testing, manufacturing and production, and product introduction and management. Open to graduate and senior-level engineering students, industrial administration students, and design students.

51-421 Basic Interaction
Fall: 9 units
This course highlights the role that visual interface designers play in the multi-disciplinary attempt to bridge the gap between functionality and usability and to introduce students to some of the unique challenges of designing within the realm of a digital, interactive medium.

51-422 Basic Interaction
Spring: 9 units
Intended for HCI double majors, this is the spring offering of 51-421. Introduction to visual interface design. This course highlights the role that visual interface designers play in the multi-disciplinary attempt to bridge the gap between functionality and usability and to introduce students to some of the unique challenges of designing within the realm of a digital, interactive medium.

51-423 Pieces
Intermittent: 9 units
In this class students will self-define a problem and take a holistic design approach to solving it. They will “loosely” design a product / product line—anything from a clothing line with multiple silk-screened tee-shirts, to a collection of tea pots, to a group of illustrated children’s books, to a campaign / set of tools to help older adults lead a more active lifestyle. After or in tandem with the creation of this product, the student will construct an image, which will entail print media, a Web presence, packaging, and photography. By creating the product and its “marketing” effort from top-to-bottom, the student will gain a diverse set of skills in design as well as a richer understanding of the product. In the end all the pieces will come together to create a well-refined image. We will achieve this ambitious goal by various lectures, workshops, visiting artist, and constant feedback from both colleagues and course faculty. This course is for Design Seniors only.

51-424 Web Portfolio
Intermittent: 4.5 units
This course will provide an opportunity for students to design and code their online portfolio. The course covers basic elements of Web design along with the foundations of HTML, CSS, Javascript and Flash as components of the design process. Prior experience with HTML is encouraged but tutorials will be provided if necessary. This is not an Actionscript programming course.

51-425 Beginning Book Arts Lab
Fall and Spring: 6 units
Beginning Book Arts Lab Class. 6units. (This class is a prerequisite for the Advanced Book Arts Workshop Lab Class). This is a class of basic issues regarding hand bookbinding and letterpress printing. It’s purpose is to develop a basic structural sense of book forms, of flat format work and of three dimensional forms. Learning hand craft techniques, developing hand skills and the sensitivity to materials are also a goal. Binding projects assigned will target the unique nature of papers, fabrics and archival cardboards. Structural procedures and techniques will be identified with each assigned binding project. The binding projects will be: A hardcover for a paper back book, a single signature book, a multi-signature book with flat spine, and a box construction. The box project is designed and crafted to contain a small letterpress printed class edition, either in book form, or as a set of un-bound pages. The letterpress component teaches the standard issues, unique to the relief process, in press work, handset procedure of cast metal type, page form spacing, lock-up of pages in press, proofing, and production printing. Each semester a small class edition project of text content and of two-color registration, is designed, hand set and printed. Image generation can be by hand cut block, assembled type-high forms, or digital process to polymer plate. This class is not to be repeated.

51-426 Beginning Book Arts Lab
Spring: 6 units
Beginning Book Arts Lab Class. 6units. (This class is a prerequisite for the Advanced Book Arts Workshop Lab Class). This is a class of basic issues regarding hand bookbinding and letterpress printing. It’s purpose is to develop a basic structural sense of book forms, of flat format work and of three dimensional forms. Learning hand craft techniques, developing hand skills and the sensitivity to materials are also a goal. Binding projects assigned will target the unique nature of papers, fabrics and archival cardboards. Structural procedures and techniques will be identified with each assigned binding project. The binding projects will be: A hardcover for a paper back book, a single signature book, a multi-signature book with flat spine, and a box construction. The box project is designed and crafted to contain a small letterpress printed class edition, either in book form, or as a set of un-bound pages. The letterpress component teaches the standard issues, unique to the relief process, in press work, handset procedure of cast metal type, page form spacing, lock-up of pages in press, proofing, and production printing. Each semester a small class edition project of text content and of two-color registration, is designed, hand set and printed. Image generation can be by hand cut block, assembled type-high forms, or digital process to polymer plate. This class is not to be repeated.
51-427 Advanced Book Arts Workshop  
Intermittent: 9 units  
Advanced Workshop in Book Arts. 6 units or 9 units. Students will be required to plan and design projects that relate to binding, or digital printing, or letterpress printing, or hand-setting of cast metal type. Projects utilizing a combination of all processes can be planned as well. Experimental work, or Artists’ Books are also encouraged. In this class structure students will be able to plan and design projects that are complete books, with printed content, or with out content. Other flat structures, and three dimensional containers are examples of general forms that will be categorized as binding work. Emphasis for binding is working independently with a greater level of hand craft and a sensitivity to materials. Emphasis for letterpress printing is to learn in depth, and master, the general mechanical process for doing press work. Emphasis for hand typesetting is on gaining an understanding of the system of cast metal type, and to develop a sensitivity to typographic principles. Instruction will be given on an individual basis through consultation at strategic times throughout the semester. Project evaluation will be based on the success of the project work compared to each student’s written project proposal at the start of the semester. The Advanced Workshop in Book Arts can be repeated. For more complex project work this class can be continued for the following semester. Prerequisites: 51-425 or 51-426.

51-428 Time, Motion and Communication  
Spring: 9 units  
This course focuses on designing and presenting messages on a screen. The differences between paper-based and screen-based communication are discussed and become the departure point for exercises and projects. Working with word, image, sound, and motion, along with Adobe After Effects, students develop responses to a variety of project briefs. An attitude of exploration is stressed, with an emphasis on visual voice, performance, and communication. Content will include personal messages and timely information. Proficiency with After Effects is a requirement. Preference will be given to Design students, both undergraduate and graduate, but seats for non-majors are reserved.

51-431 Revealing Place  
Intermittent: 9 units  
Revealing Place is a documentary photography class where students will use their cameras to explore a group, idea, and/or location and tell its story. Students will use photography as a way to engage community, document social phenomenon, and define what’s happening at that moment in the history of their chosen setting.

51-433 Advanced Interaction  
Intermittent: 9 units  
An interface is the link between a user and a product that communicates how this product will be used and creates an environment for the people who will use it. Interaction design is the process of creating and defining product behavior, encompassing both usability and aesthetic dimensions of an artifact, service, or environment. In this course, we will explore issues that pertain to the design of interfaces that act as a conduit of human touch, with a focus on a variety of design principles, information hierarchy and navigation, multi-modal information presentation, user-product interactions, and how these elements become part of a larger design process. Students will develop an interface for creating interface designs that can be reapplied in future contexts. Prerequisite: 51-421.

51-434 Experimental Form  
Intermittent: 9 units  
The Experimental Form Studio looks broadly at the discipline of industrial design with an emphasis on creating new paradigms for interactive objects. This course encourages an exploratory study of physical objects and artifacts and provides a creative and intellectual forum to re-imagine our relationship with objects. Each independently-themed project presents opportunities to consider embedded mechanics & technology, objects as interactive media, and experience-driven design. Experimental Form, at its most basic, is a process that blends play and inquiry in an open-ended way – finding the unexpected through tinkering and trying something you don’t quite know how to do, guided by imagination and curiosity. In this course, there are no instructions, no failures, no prescribed right or wrong ways of doing something. In this sense, Experimental Form complements the core ID Studio sequence by providing a playground for intellectual discourse, experimental trial and error, and refining individual processes for designing. This is your sandbox for pre-design they intend to investigate and then produce one or more furniture pieces developed from their findings. Materials and processes applied to the project are limited only by the resources the student can bring to bear. Assigned readings and a series of in-class discussions will focus on the influence of craftsmanship in design, and on how the behavior of the user is influenced by the form or aesthetic language of the artifact. Lab fee & material purchases required. Prerequisite: 51-451.

51-435 Presentation & Pitch Design  
Intermittent: 4.5 units  
Presentation & Pitch Design: The premise of the course is to provide design students with the fundamental tools to effectively present and pitch their designs. The foundation of the course is best explained by Dick Buchanan he states, “The designer, instead of simply making an object or thing, is actually creating a persuasive argument that comes to life whenever a user considers or uses a product as a means to some end.” (Buchanan, R. 2000). I am looking to facilitate skill development using narratives as a medium for design students to present and pitch the intent of their designs based on five core principles: intentional positioning (empathize with your audience) restraint in preparation (concise structure) simplicity in design (visual congruence with design artifact) clarity in rhetoric (know your message) naturalness in delivery (be yourself) Upon completion of this class, students will have mastery in the Five Core Principles mentioned. They will be able to: Identify and cater to their audience’s needs Empathize with their audience and adjust accordingly Craft a narrative that captures their design intention(s) Visually compliment their design in their presentation Clearly develop their message (pitch) Develop and present in their own style.

51-439 Design for Service Studio  
Intermittent: 9 units  
Services constitute more than 79.2% of the US economy. The service sector has been increasing substantially while the commodities and manufacturing sectors have experienced a steep decline. Yet, service providers have historically under-utilized design in its business strategy and development. During this project course, intended to work in conjunction with Designing for Service Seminar, we will extend the idea of design as more than aesthetics and provide the opportunity for students to practice embodying its perspective and process, mapping design theory to project process. Students will spend the semester in teams, working with the Pittsburgh Post-Gazette to deeply understand their users and stakeholder’s experiences, needs, and desires. We will explore the role of journalism and news in society, the volatile sector as a whole, and the challenges facing newspapers in America. The human-centered design approach will employ ethnographic research methods, allowing for teams to uncover insights and observations about patterns. Students will in turn learn to synthesize these findings into appropriate models, prototype concepts, and look for opportunities. The design solutions are intended to inform elements of the paper’s competitiveness, creativity, development and future service innovations. The final deliverable will be refined solutions as illustrated in a presentation and process document.

51-441 Product Planning & Development Fall: 4.5 units  
Product Planning and Development The course will explore examples of case studies of product planning strategy from several levels. The first level will explore how companies establish brand strategies and determine the products that they want to compete in. The second level will look at how companies develop overall product lines that express corporate brand and then also connect with consumers in product markets. The third level is the planning of specific product programs. The course will begin as a seminar discussion of the opportunities for teams and end with a full-blown product planning and development of a product strategy using an actual company’s brand identity. This course is for seniors or graduate students in design, BHA and engineering, and graduate business students.

51-451 Fundamentals of Joinery & Furniture Design  
Fall: 9 units  
Intensive introduction to traditional joinery techniques and the properties of wood through the use of textbook studies and lab experiments. Emphasis placed on how these techniques and properties influence design decisions. Students will learn how to set up, sharpen and use traditional hand powered tools. This acquired knowledge will be applied in the design and realization of a piece of wooden furniture. Limited enrollment. Lab fee and material purchases required. Prerequisite: 51-243.

51-452 Furniture Design II  
Spring: 9 units  
A continuation of 51-451, this course explores a much broader range of issues related to furniture design. Students will identify and define in a general area the range of issues which are pertinent to the designs they intend to investigate and then produce one or more furniture pieces developed from their findings. Materials and processes applied to the project are limited only by the resources the student can bring to bear. Assigned readings and a series of in-class discussions will focus on the influence of craftsmanship in design, and on how the behavior of the user is influenced by the form or aesthetic language of the artifact. Lab fee & material purchases required. Prerequisite: 51-451.
51-453 Applied User Research
4.5 units
This course is an opportunity for students to study how user research applies to concrete design projects in an organizational context. We will study three different design projects that pursue a human-centered design approach: The Domestic Mail Manual (DMM) Transformation Project by the United States Postal Service, the Australian Taxation Project by the Australian Tax Office, and the Income Tax Form Redesign by the Internal Revenue Service of the United States. Students will trace the role of user research in each case. The class will take the format of a seminar with lectures, presentations and readings. Together with actual samples from the three case studies, they will provide a background for rich discussions. Students will walk away with three key insights into applied user research: They will understand how user research applies to a complex system, such as an organization. Simultaneously, students will gain an understanding of the opportunities and the potential pitfalls that arise when co-designing with a client. Finally, by studying the design process and the artifacts that were developed by these three projects, the contribution of user research in designing interactions of individuals with organizations, the effect of user research on an organization and the role of user research in organizational change will become evident. Open to graduate and advanced undergraduate students in design. Because of the nature of the projects and the organizations involved, this course may also be of interest to students with a background in organizational behavior, management and public policy.

51-471 Practicing Design
Fall: 9 units
This is a lecture course covering all aspects of design practice. Students learn to formulate a plan for professional practice, market creative services, manage projects, and understand the legal and ethical issues associated with design practice. This course will also address the changing role of the design profession. Visiting professionals, case studies, and supplementary readings provide resources for class discussion. This course is required for all senior design majors.

51-472 Globalization and Design
Intermittent: 4.5 units
Designers are often required to plan products for markets around the world. Diversity of cultural value plays a central role in user experience and product development in the global context. This mini course is a seminar that explores the topic of culture. The first part of the course will provide students with terminology, perspectives, concepts, and knowledge based on discussions of selected readings from the classic and contemporary literature as well as diverse examples from the field. The second part of the course will examine how these theories relate to design research and practice. Individual and group assignments will help students relate the concepts to the practice of design.

51-479 Design Methods: Analysis and Creativity
Intermittent: 9 units
Design Methods: Analysis and Creativity. Most designers recognize that “process” is an important part of professional practice, yet the “methods” that try to capture design process are varied and often conflicting. The goal of this course is to explore design methods and their supporting techniques, seeking a better understanding of the pattern of inquiry upon which they are based. The course will include a close reading of works in the “design methods movement” of the 1960s and 1970s. This movement rightly occupies a central place in the development of design methods and methodology in the twentieth century. It is at times insightful, at other times confusing and dissatisfying. Nonetheless, it is essential to understand what was attempted and actually accomplished by individuals such as Bruce Archer, John Chris Jones, Horst Rittel, and Christopher Alexander. Our current understanding of design methods, including the new forms of user research, is grounded on their work.

51-481 Visualizing Stories
Intermittent: 4.5 units
Students This course is open to HCI and Design graduate students and senior-level Design students. Students need a basic knowledge of communication and interaction design. Experience with interactive prototyping, digital video editing, and graphic layout are encouraged but not required. Course Description When viewers watch a TV news story, they never see the whole story. Instead they see, a short synopsis of the back-story, a quick update of the latest findings, and speculations on the future outcome. Will he be found guilty? Will she be re-elected? Will the hurricane damage more property than last time? What viewers never get from TV news is a complete view of how a story evolves over time from beginning to end. In this project course students will work in small teams to develop visualizations of both individual current news stories as well as the evolution of these stories over time. Working with a small set of CNN video clips, students will produce both static and interactive visualizations that offer insights into the story that a traditional linear video broadcast can never provide. In much the same way Minard’s map on Napoleon’s march to Moscow captures an entire story in a single image, students will work to reveal the relevant features that best communicate both what is happening in the individual news story as well as the larger story evolving over many weeks.

51-488 Design, Management and Organizational Change
Intermittent: 9 units
Design, Management, and Organizational Behavior 51-488/51-788 The goal of this course is to help Design students better understand how organizations affect the practice of design and, in turn, how the practice of design and affect organizational life. Topics covered will include the history and theory of management, some of the current practices of management that have direct bearing on design (such as strategic planning), and some of the central concepts of organizational theory that will help students learn to interpret and work within organizations. Pre-requisites: this course is intended primarily for design graduate students, with a few seats reserved for undergraduate Design majors. Non-Design majors must obtain the instructor’s permission to register for this course.

51-499 Senior Independent Study
All Semesters
Guidelines for independent study in the Design Office. Proposals must be approved by faculty before pre-registration.

Drama Courses

54-011 Warmup
Fall: 1 unit
Drama majors only.

54-012 Warmup
Spring: 1 unit
Drama majors only
Pre-requisite: 54-011.

54-101 Acting I
Fall: 10 units
A knowledge and beginning understanding of the components of acting. Basic exercises, improvisations and prepared work in relaxation, concentration, imagination, communication. The ability to create the reality of a given situation in theatrical terms. Craft fundamentals in preparation for scene study. The beginning development of the students creative resources. This course is open to Drama majors only.

54-102 Acting I
Spring: 10 units
A knowledge and beginning understanding of the components of acting. Basic exercises, improvisations and prepared work in relaxation, concentration, imagination, communication. The ability to create the reality of a given situation in theatrical terms. Craft fundamentals in preparation for scene study. The beginning development of the students creative resources. This course is for Drama majors only.
Pre-requisite: 54-101.
54-103 Speech I  
Fall: 6 units  
(Speech & Phonetics) The course introduces students to the pronunciation of the sounds of the Standard American English Dialect. The International Phonetic Alphabet (IPA) is used to teach the students a symbol for each vowel, diphthong and consonant sound of the dialect. This process will strengthen the student’s production of the thirty-nine sounds and will eliminate regional characteristics. Intonational patterns of the dialect are also studied and practiced. The work is applied to weekly presentations of poetic texts. Phonetic transcription is required of class participants from the beginning of this course. This course is for Acting and Directing majors only.

54-104 Speech I  
Spring: 6 units  
(Speech and Phonetics) The second semester is a continued investigation and drill of the thirty-nine sounds of the Standard American English Dialect as well as the music of the dialect. Students apply the principles of the five degrees of stress of the dialect, inflections and intonational patterns and the use of the weak forms of certain parts of speech of the English language to the weekly presentations. The last four weeks of this semester are focused on preparation for a public performance of each student’s favorite poet’s poetry, all of which is memorized and transcribed phonetically. This course is for Acting and Directing majors only. Prerequisite: 54-103.

54-105 Voice/Alexander I  
Fall: 5 units  
Voice 1 Fall Voice 1 covers the introduction to voice training based on the Linklater voice work as well as other techniques. Students will learn basic warm ups, identification of healthy voice use and application of voice work to acting work, based on Michael Shurtleff THE AUDITION. Required Text FREEING THE NATURAL VOICE, second edition by Kristin Linklater. Time permitting some basic introductory work to the Alexander Technique will be covered.

54-106 Voice/Alexander I  
Spring: 5 units  
Voice 1 Spring (prerequisite Voice 1 fall) A continuation of Voice 1 introducing the exploration of resonators, (resonex ®), Shakespeare and personal writing. Students will develop a basic daily vocal practice and learn how to lead a basic warm up. Time permitting, continuation of introductory Alexander work. Prerequisite: 54-105.

54-107 Movement I  
Fall: 4 units  
This course serves as a foundation for all future movement studies. Kinesthetic awareness and responsiveness is developed through the introduction of the Viewpoints method of physical training. The importance of physical expressivity and specificity in storytelling is achieved by the creation of physical movement based compositions. This is a required course for all first year undergraduate Acting and Musical Theatre and Directing students. Other students may register for this course only with the instructor’s permission.

54-108 Movement I  
Spring: 4 units  
Prerequisite: 54-107 or permission of the instructor. This course focuses on the ability to make physically specific choices in order to convey character through an introduction to the basic principles of Laban Movement Analysis and further work in the Viewpoints method of actor training. This course is required for all first year undergraduate Acting and Musical Theatre majors. Prerequisite: 54-107.

54-109 Dramaturgy I: Approaches to Text  
Intermittent: 9 units  
This class focuses on building the skills and knowledge necessary for a dramaturgical analysis of plays for production. Course readings introduce students to key theoretical approaches to literature that can provide new insights and interpretations of plays. Course assignments involve students in dramaturgical research, oral presentation, and critical writing on the plays we read. Required for Freshmen Dramaturgs; open to other majors with instructor permission.

54-110 Text  
Fall: 2 units  
This class is in conjunction with Acting I in the School of Drama. The actor/director learns how to investigate the written text and translates it actively for performance. Corequisite: 54-101.

54-111 Text for Actors  
Spring: 2 units  
This class is in conjunction with Acting I in the School of Drama. The actor/director learns how to investigate the written text and translates it actively for performance.

54-121 Directing I: Sources  
Fall: 9 units  
An interdisciplinary exploration of the directors art through the study of modern art movements. Students will be required to do extensive research on one specific movement i.e. Surrealism or abstract expressionism, and create a performance piece based on the visual and social elements of that particular movement.

54-122 Directing I: Sources  
Spring: 9 units  
A continuation of the previous semester focusing on Music and Dance of the twentieth century and how they influence the directors art. Prerequisite: 54-121.

54-123 Ballet I  
Fall: 5 units  
This course uses Classical technique (Ballet) to build body placement, alignment and muscular strength and flexibility. Designed to help the student develop a way of learning how to work and train for any dance form. This technique is the basis of the choreography in American musical theater. This course is for Music Theatre majors only. Permission of instructor.

54-124 Ballet I  
Spring: 5 units  
This course continues Classical technique (Ballet) to build body placement, alignment and muscular strength and flexibility. Designed to help the student develop a way of learning how to work and train for any dance form. This technique is the basis of the choreography in American musical theater. This course is for Music Theatre majors only. Prerequisite: 54-123 and permission of instructor. Prerequisite: 54-123.

54-125 Music Skills I  
Fall: 2 units  
The students explore the basics of music theory, which includes intervals, rhythm, notation and musical vocabulary. Emphasis is on acquiring these basic skills through sight singing.

54-126 Music Skills II  
Spring: 2 units  
The students explore the basics of music theory, which includes intervals, rhythm, notation and musical vocabulary. Emphasis is on acquiring these basic skills through sight singing. Prerequisite: 54-125.

54-151 Stagecraft  
Fall: 15 units  
The stagecraft class is designed to provide an introductory level of technical training in all the theatrical technical disciplines over the course of two semesters. The intent is to produce people who can capably fill roles on production crews and perhaps serve as an assistant to the head of the crew. Course content will cover materials, tools & equipment, procedures, safety and operations for Carpentry, Props, Paints, Metals, Costumes, Lights, Sound, Rigging, and Run Crew. As well as providing opportunity and experience to grow as technicians, this content will also help establish a foundation to begin the process of becoming managers and designers. As craft skills are often best communicated in a master/apprentice environment this course is set up as a mentored practical experience. This course will require additional time during the evening and on weekends.

54-152 Stagecraft  
Spring: 11 units  
The stagecraft class is designed to provide an introductory level of technical training in all the theatrical technical disciplines over the course of two semesters. The intent is to produce people who can capably fill roles on production crews and perhaps serve as an assistant to the head of the crew. Course content will cover materials, tools & equipment, procedures, safety and operations for Carpentry, Props, Paints, Metals, Costumes, Lights, Sound, and Rigging. As well as providing opportunity and experience to grow as technicians, this content will also help establish a foundation to begin the process of becoming managers and designers. As craft skills are often best communicated in a master/apprentice environment this course is set up as a mentored practical experience. This course will require additional time during the evening and on weekends.
54-157 Basic PTM
Fall: 6 units
Students in the Basic PTM course are exposed to the very fundamentals, the primitives, of entertainment technology. The intent is to provide the absolutely strongest beginning for all the work to come, to provide a solid foundation for students and instructors to build upon. Production professionals routinely perform organizational tasks. In order to be able to meet that challenge, students will need to build a toolkit of information and procedures. That toolkit will be comprised of knowledge of the kinds of parameters and techniques that are normally selected, the indices that parameters and techniques are evaluated against, and many of the wide range of issues that might point a manager toward one decision or another. There also exists an entire pantheon of information that people typically learn "on the job." Activities and information presented in this course are designed to try to expose students to as much of this on the job type development as possible with the goal of leapfrogging them past the bottom rung of the workplace ladder. Drama Design/Production majors only, or with instructor permission.

54-158 Basic PTM
Spring: 6 units
Students in the Basic PTM course are exposed to the very fundamentals, the primitives, of entertainment technology. The intent is to provide the absolutely strongest beginning for all the work to come, to provide a solid foundation for students and instructors to build upon. Production professionals routinely perform organizational tasks. In order to be able to meet that challenge, students will need to build a toolkit of information and procedures. That toolkit will be comprised of knowledge of the kinds of parameters and techniques that are normally selected, the indices that parameters and techniques are evaluated against, and many of the wide range of issues that might point a manager toward one decision or another. There also exists an entire pantheon of information that people typically learn "on the job." Activities and information presented in this course are designed to try to expose students to as much of this on the job type development as possible with the goal of leapfrogging them past the bottom rung of the workplace ladder. Drama Design/Production majors only, or with instructor permission.

54-159 Production Symposium I
Fall: 6 units
Hands on experience in most aspects of building and running a production.

54-160 Production Symposium I
Spring: 6 units
Hands on experience in most aspects of building and running a production. Prerequisite: 54-159.

54-162 Introduction to Costume Design
Spring: 6 units
A rigorous introductory Costume Design course for School of Drama Sophomores in the second semester who have just declared a Costume major. Basics of the design process are covered in discreet exercises. Drawing, sculpture, play and character analysis, research, figure drawing and painting are included. Collaboration with students of other design disciplines on final project. Prerequisites: 54171 & 54172 Basic Design. For non-Costume majors an interview/portfolio review and instructor permission are required for admission into this course. Prerequisites: 54-171 and 54-172.

54-163 Production for Non Majors
Fall: 6 units
Basic Introduction and practice for non-majors, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting. Special Permission required to take this course.

54-164 Production for Non Majors
Spring: 6 units
Basic Introduction and practice for non-majors, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting. Special Permission required to take this course.

54-166 Introduction to Sound Design for Theatre
Spring: 6 units
Students explore the basic principles and theories of sound design from technical, psychological and aesthetic standpoints. Course work includes instruction in the controllable properties of sound, practical planning of sound plots, cue creation, and the design process. Prerequisites: 54171 & 54172 Basic Design and 54-231 Design For The Stage. Drama majors have priority, however this course is also open to Music Technology majors and minors, or with permission of instructor. Prerequisites: 54-171 and 54-172 and 54-231.

54-169 StudioCraft
Fall: 13 units
The studiocraft course provides beginning level instruction in Drawing, Hand Drafting, and CAD Drafting.

54-170 StudioCraft
Spring: 8 units
The studiocraft course provides beginning level instruction in Drawing, Hand Drafting, and CAD Drafting.

54-171 Basic Design
Fall: 6 units
A year-long studio course exploring the principles and elements of design and research in discreet exercises and projects first semester. Second semester focuses on the theatrical design process and each of the disciplines with projects in scene, costume, lighting, and sound design as well as a strong component in drawing. Reports throughout the year expose the students to designers theatres and artists of note in the world. This section is concurrent with Drafting and Figure Drawing sections. PREREQUISITE: Declared Design/PTM focus in the School of Drama FOR: First Year Undergraduate Students.

54-172 Basic Design
Spring: 6 units
A year-long studio course exploring the principles and elements of design and research in discreet exercises and projects first semester. Second semester focuses on the theatrical design process and each of the disciplines with projects in scene, costume, lighting, and sound design as well as a strong component in drawing. Reports throughout the year expose the students to designers theatres and artists of note in the world. This section is concurrent with Drafting and Figure Drawing sections. PREREQUISITE: Declared Design/PTM focus in the School of Drama FOR: First Year Undergraduate Students.

54-175 Conservatory Hour
Fall: 1 unit

54-176 Conservatory Hour
Spring: 1 unit
A year-long discussion class for first-year Drama students. Open to non-majors interested in declaring a Drama minor.

54-177 Foundations of Drama I
Spring: 13 units
In this course, students receive training in the basic analysis of scripts to determine key elements of structure, plot, characterization, thematic content, theatricality, and aesthetics. In addition, the course provides training in dramaturgical research and writing. Registration for this course is limited to Drama majors. All other majors must receive the instructor’s permission.

54-178 Foundations of Drama I
Spring: 6 units
In this course, students receive training in the basic analysis of scripts to determine key elements of structure, plot, characterization, thematic content, theatricality, and aesthetics. In addition, the course provides training in dramaturgical research and writing. Registration for this course is limited to Drama majors. All other majors must receive the instructor’s permission.

54-184 Dramaturgy 2: History and Practice
Intermittent: 9 units
This class continues the basic skill training of the dramaturg, emphasizing the history of world theatre from a dramaturgical perspective, a broad grounding in the history of critical theory of drama, and skill-building exercises in research, presentation, and writing. Required for Freshmen Dramaturgs; open to other majors with instructor permission.

54-187 Introduction to Playwriting
Fall: 6 units
Students will be introduced to the major components of writing for the stage, including dramatic action, character, and dialogue. Exercises designed to familiarize students with the tools available to the playwright will be assigned, and readings of exercises and works-in-progress will take place on a weekly basis. By the end of the course each student will have completed the first draft of a one-act play.
54-188 Introduction to Playwriting
Spring: 9 units
Students will be introduced to the major components of writing for the stage, including dramatic action, character and dialogue. Exercises designed to familiarize students with the tools available to the playwright will be assigned each week. Readings of exercises and work-in-progress will take place on a weekly basis. In addition to reading each other’s work, members of the class will also serve as the first test audience for your colleagues. Students will be expected to discuss their reaction to each exercise that is read. The final project for the course will be the completion of the first draft of a Ten-Minute play.

54-189 Advanced Playwriting
Fall: 9 units
This course is intended to continue the process of familiarizing students with the basic components of dramatic writing, paying particular attention to the most basic building block of all effective plays — dramatic action. We will also focus on the development of an effective structure for a one-act play, and on finding theatrical conventions which both suit the story and make it live on stage. In some cases, students may work on a long play with permission of instructor. Readings will focus on contemporary plays that suggest effective alternative structures and unique uses of theatrical language. Prerequisites: 54187 or 54-188.

54-190 Advanced Playwriting
Spring: 9 units
This course is intended to continue the process of familiarizing students with the basic components of dramatic writing, paying particular attention to the most basic building block of all effective plays — dramatic action. We will also focus on the development of an effective structure for a one-act play, and on finding theatrical conventions which both suit the story and make it live on stage. In some cases, students may work on a long play with permission of instructor. Readings will focus on contemporary plays that suggest effective alternative structures and unique uses of theatrical language. Prerequisites: 54187 or 54-188.

54-191 Acting for Non-Majors
Fall: 9 units
This class is designed for non-acting majors and introduces the student to the basic principles of acting, character study and improvisation. One semester course.

54-192 Acting for Non-Majors
Spring: 9 units
This class is designed for non-acting majors and introduces the student to the basic principles of acting, character study and improvisation. One semester course.

54-193 Introduction to Screenwriting
Fall: 9 units
This course is designed to introduce basic screenplay structure and formatting. Readings and films to see will be assigned. A short film or step-outline of a full length film are to be completed by the end of the semester.

54-194 Introduction to Screenwriting
Spring: 9 units
This course is designed to introduce basic screenplay structure and formatting. Readings and films to see will be assigned. A short film or step-outline of a full length film are to be completed by the end of the semester.

54-195 Advanced Screenwriting
Fall: 9 units
This course is designed to give writers a variety of tools they can use in writing or rewriting a current project full-length screenplay. There will films assigned to watch and analyze. Either a first draft or a rewritten version of a full length screenplay is to be completed by the end of the semester. Permission only. Prerequisites: 54-193 or 54-194.

54-196 Advanced Screenwriting
Spring: 9 units
This course is designed to give writers a variety of tools they can use in writing or rewriting a current project full-length screenplay. There will films assigned to watch and analyze. Either a first draft or a rewritten version of a full length screenplay is to be completed by the end of the semester. Prerequisites 54193 or 54194, or instructor permission.

54-200 Ghost Light Forum
Fall: 1 unit
Programmed and taught by senior students in the dramaturgy program, this course is required for all Dramaturgy Majors and meets once per week to discuss issues and topics of significance to the dramaturgy community.

54-201 Acting II
Fall: 12 units
Scene study: the fundamental techniques needed to participate in the developing conflict within the imaginary world. Character building through unfamiliar behavior and beliefs; relationships; language. Spring semester: The use of classical texts and ensemble playing. The deepening of the actors inner resources to be supported by the craft techniques. Prerequisites: 54-101 and 54-102.

54-202 Acting II
Spring: 12 units
Scene study: the fundamental techniques needed to participate in the developing conflict within the imaginary world. Character building through unfamiliar behavior and beliefs; relationships; language. Spring semester: The use of classical texts and ensemble playing. The deepening of the actors inner resources to be supported by the craft techniques. Prerequisite: 54-201.

54-203 Voice and Speech II
Fall: 5 units
The actors take a more concentrated approach to elevated text. The course focuses on the effective production of classical text. The warm-up sessions are geared towards preparing the student actors for the extravagant language from Shakespeare’s plays and sonnets. Meter, imagery and further specific text work is also employed to encourage each student to find clear shape in the work. A repertoire of at least five classical monologues will come from the course work. Prerequisites: 54-103 and 54-104.

54-204 Voice and Speech II
Spring: 6 units
The actors take a more concentrated approach to elevated text. The course focuses on the effective production of classical text. The warm-up sessions are geared towards preparing the student actors for the extravagant language from Shakespeare’s plays and sonnets. Meter, imagery and further specific text work is also employed to encourage each student to find clear shape in the work. A repertoire of at least five classical monologues will come from the course work. Prerequisites: 54-103 and 54-104 and 54-203.

54-205 Ballet II
Fall: 3 units
This course is designed to build on the technical foundation, work habits and professional behavior established in Ballet I. The material presented expands the classical dance vocabulary to the next level of difficulty. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor. Prerequisites: 54-123 and 54-124.

54-206 Ballet II
Spring: 3 units
This course continues to build on the technical foundation, work habits and professional behavior established in Ballet I. The material presented expands the classical dance vocabulary to the next level of difficulty. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-205 and 54-106 and 54-205.

54-207 Movement II
Fall
This entire term focuses on the Neutral Mask, a completely non-verbal masked movement form, through which students search for a neutral base, both physically and psychologically, a place of complete presence in the present. The mask allows them to uncover all that is emotional in the body; the “baggage” carried from role to role, and provides techniques to free them from these limitations. Identifications with other forms of energy, the four elements, seasons, materials, colors and plant life give students new insights in the process of character development. The Neutral Mask work is immediately reinforced with applications to their scene work in Acting class. Prerequisites: 54-107 and 54-108.
54-208 Movement II
Spring: 3 units
This term is divided between two classic physical forms: Commedia dell'Arte and Clowns. In the first half of the semester students wear the half-masks of the archetypal Commedia characters (Harlequin, Pantalone, et al), to learn their psychology and physiognomy, improvise on historical and contemporary scenarios, and apply Commedia technique to modern comedy. Commedia dell'Arte gives them the tools to tackle physical comedy from any era, past or present. In the second half of the term students discover their personal Clowns. This clown has nothing to do with the American Barnum & Bailey Circus clown; this is not a character or caricature, but rather a revelation of the clown each student hides under the mask of adulthood. Discovering this clown gives them all a way to laugh at themselves, to uncover what makes each individual uniquely funny; it also lets them see how we only laugh at truth and in the personal material lies universal humor. Inside this freedom is the technique to know what's funny and why, and the ability to apply these rules in comedy.
Prerequisites: 54-107 and 54-108 and 54-207.

54-210 Script Analysis
Fall and Spring: 2 units
Drama majors only.

54-211 Actor Dance II
Fall: 3 units
This course introduces the basic, fundamental vocabulary of Classical technique (Ballet) to train the body in proper alignment, placement, and muscular strength. Course closed: Only for Acting majors in Drama.
Prerequisite: Permission of instructor
Prerequisites: 54-101 and 54-102.

54-212 Actor Dance II
Spring: 3 units
A continuation of Classical technique (Ballet) and a unit of social dance styles, waltz, polka, foxtrot, tango, swing. Course closed: Only for Acting majors in Drama.
Prerequisite: 54-211 and Permission of instructor
Prerequisites: 54-101 and 54-102 and 54-211.

54-213 Singing for Actors II
Fall: 3 units
The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Towards the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.
Prerequisites: 54-101 and 54-102.

54-214 Singing for Actors II
Spring: 3 units
The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Towards the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.
Prerequisites: 54-101 and 54-102.

54-217 Jazz II
Fall: 2 units
This course is designed to incorporate the strength of classical dance technique to a jazz dance style. Training the body in a variety of contemporary jazz styles, i.e. Latin, Blues, Lyric, African, using body isolations and rhythmic patterns. Course closed: Only for Music Theatre majors in Drama.
Prerequisite: Permission of instructor
Prerequisites: 54-123 and 54-124.

54-218 Jazz II
Spring: 2 units
This course continues to incorporate the strength of classical dance technique to a jazz dance Training the body in a variety of contemporary jazz styles, i.e. Latin, Blues, Lyric, African, using body isolations and rhythmic patterns. Course closed: Only for Music Theatre majors in Drama.
Prerequisite: 54-217 and Permission of instructor
Prerequisite: 54-217.

54-219 Music Theatre Literature and Repertoire
Fall: 4 units
The students are exposed to many music scores of the basic choral and musical theatre literature. The students learn this repertory, reinforcing the principals of music theory learned in the first year.
Prerequisites: 54-125 and 54-126.

54-221 Directing II: Fundamentals
Fall
THE FUNDAMENTALS OF DIRECTING: This is a Fall-semester course for 2nd-year students of all options introducing the fundamentals of the director's craft: text analysis; the work script with column method & blocking notation; determining the purpose of the writing; the concept of Action & Change (beats & transitions); practical use of the Six Aristotelian Elements of Drama; Genre & Style; the Dramatic Question; Levels in the Creative Process; Visual Vocabulary & Staging Tools including planes, levels, values of stage space, body positions; composition; picturization; emphasis; & movement; entrances & exits; the ground plan. Work includes unscripted exercises, then scripted exercises on an open stage & then within a detailed ground plan, Additional goals: to work in a professional manner; to value preparation, analysis & organization.

54-222 Directing II: Fundamentals
Spring: 9 units
A continuation of the work done in the first semester of Directing II. Limited to directing majors and BHA directors
Prerequisite: 54-221.

54-223 Tap II
Fall: 2 units
This course trains the student to develop a comfort level to execute percussive sounds, in a variety of percussive rhythmic patterns while applying the technical foundation of alignment and placement from classical technique. Course closed: Only for Music Theatre majors in Drama.
Prerequisite: Permission of instructor
Prerequisites: 54-123 and 54-124.

54-224 Tap II
Spring: 2 units
This course continues to technically train the student in a variety of percussive rhythmic patterns. Course closed: Only for Music Theatre majors in Drama.
Prerequisite: 54-223 and Permission of instructor
Prerequisite: 54-223.

54-226 Acting a Song
Spring: 4 units
Mines the personal life experience to bridge the gap between the Performer and the Song Lyric. Exercises are designed to break down internal blocks built by the expectation of Technical Perfection. The visceral is valued over the intellectual when approaching the Song Material. The students are exposed to groups of composers divided into units including Gershwin, Porter, Rogers and Hammerstein, Bernstein, Coleman, Sondheim to the present composers. Each student prepares and performs the given songs and receives critique and instruction from each of the music and the acting teachers.
Prerequisite: 54-219.

54-229 Mind the Gap
Fall: 9 units
Drama majors only. Required for all Sophomore Design and Production majors. Bring tools.
Prerequisite: 54-172.

54-230 Make-up for Designers
All Semesters: 6 units
PREREQUISITE: Design/PTM major in the School of Drama Basic techniques of stage make-up and their adaptation to theatrical styles.

54-231 Design for the Stage
Fall: 6 units
This course is divided into four minis to introduce the student to the design process for costumes, lighting, scenery and sound. Prerequisite: 54172 Prerequisite: 54-171.

54-232 Design for the Stage
Spring: 9 units
This course deals with the fundamental needs and responsibilities of the scenic and costume designer. Emphasis is on the development of ideas based on a dramatic text. Students are asked to interpret a text and create a visual statement based on that interpretation through the design process. Studio work is included in the course work.
54-237 Scenic Painting I  
Fall: 6 units  
This is a one semester studio course in the foundations of scenic painting for theater and related fields. Students will complete projects that address the following topics: preparation of and paint techniques for both soft goods and hard covered surfaces, drawing and painting to scale, representing textures in both 2 and 3 dimensions, and color mixing. Subject matter changes often and may include: architecture, natural and man-made textures, drapery, interior/exterior scenes, the human figure, still life objects.

54-238 Scenic Painting I  
Spring: 6 units  
This is a studio course in the foundations of scenic painting for theater and related fields. Students will complete projects that address the following topics: preparation of and paint techniques for both soft goods and hard covered surfaces, drawing and painting to scale, representing textures in both 2 and 3 dimensions, and color mixing. Subject matter changes often and may include: architecture, natural and man-made textures, drapery, interior/exterior scenes, the human figure, still life objects.

54-239 History of Architecture and Decor  
Fall  
This slide/lecture course is a survey of architecture, interiors and furniture from ancient Egypt to the beginnings of the 20th Century.

54-240 History of Architecture and Decor  
Spring  
This slide/lecture course is a survey of architecture, interiors and furniture from ancient Egypt to the beginnings of the 20th Century.

54-241 Improv Class  
Fall: 4 units  
This course for Sophomore Actors not only sharpens their skills as ensemble performers, but also allows for more playfulness, creativity and exploration, cultivating risk-taking and a certain abandon. Divided into two separate sections, the course concentrates on non-verbal, psychological improv to help the student actor achieve a kind of physical truth and spontaneity, while becoming aware of the importance of the body in conveying information; the second half is devoted entirely to comedy improv and may culminate in an original comedy improv show in the UC lobby.

54-242 Improvisation  
Spring: 2 units  
This course is for Sophomore Actors only. This course not only sharpens their skills as ensemble performers, but also allows for more playfulness, creativity and exploration, cultivating risk-taking and a certain abandon. The course concentrates on non-verbal psychological improv, helping actors achieve a kind of physical truth and spontaneity, while becoming aware of the importance of the body in conveying information. Prerequisites: 54101 & 54102 Acting I, and 54207 Movement II.

54-245 History of Clothing  
Fall  
FOR: All Students. Drama Students have priority. This course explores the development of garments used in ancient Egypt to the beginning of the 20th Century. Topics include clothing and textiles used in ancient Egypt and from the society from which they spring. Course involves lectures, slides, research projects, quizzes and exams, the time line continues through the year. Second semester can be taken separately with permission of the instructor. 4 units for undergrad Directors, 6 units for everyone else. PRE-REQUISITES: None.

54-246 History of Clothing  
Spring  
Open to all students. Drama majors have priority. This course explores the development of garments used in ancient Egypt to the beginning of the 20th Century. Topics include clothing and textiles used in ancient Egypt and from the society from which they spring. Course involves lectures, slides, research projects, quizzes and exams, the time line continues through the year. Second semester can be taken separately with permission of the instructor. 4 units for undergrad Directors, 6 units for everyone else. PRE-REQUISITES: None.

54-247 Dramaturgy 3:Adaptation  
Intermittent: 9 units  
Open to non majors with instructor permission. Prerequisites: 54-109 and 54-184.

54-249 Stagecraft II  
Fall: 14 units  
Stagecraft II presents advanced shop skills and beginning department head skills for Scenery, Lighting, and Costumes. This course will require additional time during the evening and on weekends. Prerequisites: 54151 and 54152 OR Instructor Permission  
Prerequisite: 54-151.

54-250 Introduction to Scenic Design  
Intermittent: 6 units  
An introduction to the principles and practices of designing scenery emphasizing the interpretation and development of ideas based on a text. Prerequisites: Basic Design, Studiocraft. Drama majors have priority. Non-majors may be allowed in with instructor permission. Prerequisites: 54-169 and 54-171 and 54-172.

54-252 Introduction to Lighting Design  
Spring: 6 units  
Students explore the physical properties of light in various design applications and develop a process of storytelling that involves analysis, research, exploration, questionning, problem solving and implementation of a successful design product. Prerequisite: 54231 Design for the Stage, or instructor permission. Prerequisite: 54-231.

54-256 Dramaturgy 4: Theatre Historiography  
Intermittent: 9 units  
Prerequisites: 54-109 and 54-184.

54-257 Directing: Production II  
Fall: 6 units  
Assignments as stage manager or assistant director for the Studio and Kresge Theatres.

54-258 Directing: Production II  
Spring: 6 units  
Assignments as stage manager or assistant director for the Rauh Studio and Chosky Theatres.

54-260 Production Preparation II  
Spring  
Hands on experience in most aspects of building and running a production. Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Prerequisite: Stagecraft II or instructor permission.

54-261 Production Symposium II  
Fall: 6 units  
Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Prerequisites: 54-159 and 54-160. 
Prerequisites/Co-requisites:: Introduction to Production or instructors permission. Prerequisites: 54-159 and 54-160.

54-262 Production Symposium II  
Spring: 6 units  
Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Prerequisites/Co-requisites:: Introduction to Production or instructors permission. Prerequisites: 54-159 and 54-160.

54-264 Welding  
Spring: 4 units  
An introduction to the four most common metal joining processes, including Oxyfuel processes (welding, brazing, braze welding, and bending), SMAW (stick), GMAW (MIG), and GTAW (TIG). Welding safety, equipment setup and basic welding techniques will be covered.

54-267 Conceptual Sound Design  
Fall: 9 units  
Students explore the unique qualities of audio as a design element and the development of a design process through script analysis. Emphasis on the creative application and utilization of the studio in sound shaping and soundscapes design. PREREQUISITE: 54:166 Introduction To Sound Design for Theater, 54-231 Design For The Stage. Drama majors have priority, however this course is also open to Music Technology majors and minors, or with permission of instructor. Prerequisite: 54-166.
54-268 Conceptual Sound Design
Spring: 9 units
Continuation of 54-267. Students explore the unique qualities of audio as a design element. Emphasis on the creative application and utilization of the studio in sound shaping soundscapes design, recording techniques, field recording, and mixing. PREREQUISITE: 54267 Sound Design 1 Drama majors have priority, however this course is also open to Music Technology majors and minors, or with permission of instructor. Prerequisites: 54-166 and 54-267.

54-269 StudioCraft II
Spring: 3 units
A continuation of 169/170, this course introduces applied drafting practices, perspective drafting, 3D CAD modeling, model building, and other graphical skills. Prerequisites: 54169 and 54170 OR Instructor Permission Prerequisites: 54-171 and 54-172.

54-270 Photoshop for the Theatrical Designer
Spring: 3 units
Students will begin the semester by learning the basics of Photoshop and progress by mid-semester to being able to explore the visual theatre design process through Photoshop, in scenery, lighting and costumes, in conjunction with other methods of image creation. During the second half of the semester, students will learn the basics of Dreamweaver and website creation, with each student producing and publishing a professional website. Registration for this course is limited to Drama students only. Prerequisite: 54-231.

54-271 Technical Management
Fall: 6 units
Required for all sophomore Design and PTM students. This class establishes a set of standards for creative project management and introduces students to several software packages that can be utilized within these tasks. Prerequisites: 99101 and 54158.

54-272 Scenic Fabrication and Installation
Spring: 6 units
variable 6-18 units The Scenery Fabrication & Installation course consolidates and builds upon material presented in the first semester of Basic PTM and in the second semester of Stagecraft class. Whether they intend to pursue careers as technicians, engineers, or managers, students much understand how scenery is built and what is involved in the assembly of the scenery in the theatre. Throughout the semester students will explore the materials and equipment used by all kinds of professionals in the fabrication industry. Through this exploration students will become conversant with the kinds of properties, and the advantages and disadvantages of many different items. Along with this exploration is a concurrent investigation of entertainment industry accidents. This material is valuable in how it contextualizes the kind of work students will be involved in, and helps to drive home the very real consequences of errors pertaining to scenery. In the classroom and in lab students in this course will develop their knowledge and processes for building scenery. The course has three basic units. The beginning of the semester focuses on building materials and on tool use. Through the center of the semester course material focuses on traditional scenery practices. The end of the semester material addresses rigging systems and scenery rigging practices. Laboratory assignments tied to this course will consist of carpentry assignments in the shop and carpentry and rigging assignments during load in. Occasionally students pursuing a more customized path may have lab assignments in the paint department in the shop and in the electrics department during install. All students may receive apprentice assignments in the scenery office.

54-273 Technical Direction I
Fall: 6 units
6-21 units This course is an exploration of techniques and practices of the Technical Director. The class has three main components: classroom presentation of School of Drama production technical direction process, classroom lectures centering on TD process, and project work. Over the course of the semester, students will work on two productions as paper projects. This is an opportunity to have a somewhat less stressful pass through a show, completing estimates, schedules, and drawings designed to help establish a professional foundation for the student as a technical director. All of the course components run concurrently. Prerequisites: 54272 or Instructor Permission Prerequisites: 54-158 or 54-272.

54-277 Stage Management I
Fall: 6 units
This course introduces the student to the work of a stage manager on a theatrical production. Students learn the functions and responsibilities of the stage manager. Also covered: blocking notation, cue organization, rehearsal reports and AEA rules and regulations.

54-281 Foundations of Drama II
Fall: 6 units
In this course students build on the skills of Foundations I to develop acumen in targeted research in support of production. The students learn the circles of knowledge technique to provide evidentiary arguments concerning a play script, its author, the historical contexts in which it was written, the theoretical frameworks that may be applied to its interpretations, its production history, and what knowledge is needed to bring its themes to relevance in a modern production. As in Foundations I, there is a great deal of exposure to significant texts, both artistic and philosophical, from theatre history. Registration for this course is limited to Drama majors. All other majors must request the instructor’s permission. Prerequisites: 54-177 or 54-178.

54-282 Foundations of Drama II
Spring: 6 units
In this course students build on the skills of Foundations I to develop acumen in targeted research in support of production. The students learn the circles of knowledge technique to provide evidentiary arguments concerning a play script, its author, the historical contexts in which it was written, the theoretical frameworks that may be applied to its interpretations, its production history, and what knowledge is needed to bring its themes to relevance in a modern production. As in Foundations I, there is a great deal of exposure to significant texts, both artistic and philosophical, from theatre history. Registration for this course is limited to Drama majors. All other majors must request the instructor’s permission. Prerequisites: 54-177 or 54-178.

54-291 Speech and Phonetics Instruction and Outreach I
Fall: 6 units
This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry.

54-292 Speech and Phonetics Instruction and Outreach II
Spring: 6 units
This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry.

54-294 Make-Up for Performers
Spring: 2 units
PREREQUISITE: Acting/MT major in the School of Drama. Basic techniques of stage make-up and their adaptation to theatrical styles. Prerequisite: 54-102.

54-299 Dramaturgy Production: Practical Observation
Fall
54-301 Acting III
Fall: 10 units
This is a two-semester course in Acting for Third-Year Actors & MTs who will explore performance within directed structure in various non-Fourth-Wall forms of Theatre including: Greek Tragedy, the Greek Chorus, Molière, Comedy & Brecht. This is not a course that will aspire to provide any “correct” way to play various “styles”. Rather, it is a course in which to acquire new tools & perspectives when working in new theatrical worlds. Goals include: to find the appropriate level of external expression to meet the demands of the particular text & its directed world, & to "fill the Form" believably & passionately; to make active choices within a directed framework; to learn to work within industry standards; to learn the nature of the actor’s “homework” in a directed framework; to include the Audience in the work.
Prerequisites: 54-201 and 54-202.

54-302 Acting III
Spring: 10 units
This is a two-semester course in Acting for Third-Year Actors & MTs who will explore performance within directed structure in various non-Fourth-Wall forms of Theatre including: Greek Tragedy, the Greek Chorus, Molière, Comedy & Brecht. This is not a course that will aspire to provide any “correct” way to play various “styles”. Rather, it is a course in which to acquire new tools & perspectives when working in new theatrical worlds. Goals include: to find the appropriate level of external expression to meet the demands of the particular text & its directed world, & to "fill the Form" believably & passionately; to make active choices within a directed framework; to learn to work within industry standards; to learn the nature of the actor’s “homework” in a directed framework; to include the Audience in the work.
Prerequisite: 54-301.

54-303 Speech III
Fall: 6 units
(Voice) The actors continue to strengthen their vocal techniques with voice classes, which become specific in their purpose and require the students to become responsible for their own preparation process. The class also focuses on particular performance challenges in private tutorial work. (Dialects & Accents) Dialects and accents class meets twice weekly in order to build a repertoire of ten American, British, Irish dialects and/or European accents. Each actor also develops an independent project in order to discover a process of research for additional dialects he/she may encounter in the professional world.
Prerequisites: 54-203 and 54-204.

54-304 Speech III: Accents & Dialects
Spring: 6 units
(Voice) The actors continue to strengthen their vocal techniques with voice classes, which become specific in their purpose and require the students to become responsible for their own preparation process. The class also focuses on particular performance challenges in private tutorial work. (Dialects & Accents) Dialects and accents class meets twice weekly in order to build a repertoire of ten American, British, Irish dialects and/or European accents. Each actor also develops an independent project in order to discover a process of research for additional dialects he/she may encounter in the professional world.
Prerequisites: 54-203 and 54-204.

54-305 Voice/Alexander III
Fall: 5 units
Review of Linklater work, continuation of Alexander work and introduction to the Fitzmaurice voice work. Students develop personal warm ups for particular performance challenges. Students are assigned text work complementary to acting class work, as well as personal writing projects in conjunction with the Head of Playwriting. Students are also undertake the role of voice captains in productions.
Prerequisites: 54-105 and 54-106.

54-306 Voice/Alexander III
Spring: 5 units
Students continue in Linklater voice and Fitzmaurice voice, incorporating the principles of the Alexander Technique. Students are assigned special voice research projects to do with an area of interest in voice science, voice psychology or other area. Students integrate voice with acting class and performance work and continue as voice captains.
Prerequisites: 54-105 and 54-106 and 54-305.

54-307 Movement III
Fall: 5 units
Prerequisite: 54-107, 54-108, 54-207, 54-208, or permission of the instructor. This course introduces students to the basic exercises of physical actor training developed by Tadashi Suzuki and examines more advanced uses of the Viewpoints method of actor training. Physically rigorous, this course challenges not only physical stamina, but also concentration, focus and the actor’s sense of discipline. The use of spoken text is incorporated into the exercises in an integration of all the physical aspects of the actor’s craft. This course is also designed to complement and inform the actor’s entry into rehearsal and performance work. This course is required for all third year Acting majors.
Prerequisites: 54-207 and 54-208.

54-308 Movement III
Spring: 5 units
Prerequisite: 54-307, or permission of the instructor. This course focuses on the art of stage combat. Basic techniques of unarmed stage violence are studied and an introduction to other weapons such as knife and/or single rapier may be included. Emphasis is placed not only on technique, but the acting of scenes of violence found in both classical and contemporary plays. This is a required course for all third year Acting majors.
Prerequisites: 54-207 and 54-208.

54-309 Theatre Lab
Fall: 9 units
This is a two-semester class which teaches the collaborative process of theatre — including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by junior actors, senior dramaturgs, graduate and undergraduate directors, with the playwright. This work results in 10-minute play scripts, one acts, monologue dramas, and the texts for the MFA Thesis Productions. This class is co-taught by the Acting, Dramatic Writing, Dramaturgy, and Directing Options.

54-310 Theatre Lab
Spring: 9 units
This is a two-semester class which teaches the collaborative process of theatre — including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by junior actors, senior dramaturgs, graduate and undergraduate directors, with the playwright. This class is co-taught by the Acting, Dramatic Writing, Dramaturgy, and Directing Options.

54-311 Acting Symposium III
Fall: 16 units
Performance training through projects at different levels of difficulty and staging, directed by students and presented in the studio theatre. The actor has the opportunity to put into practice with his/her peers, in a creative and experimental atmosphere, the principles and techniques developed in the classroom.
Prerequisites: 54-201 and 54-202.

54-312 Acting Symposium III
Spring: 16 units
Performance training through projects at different levels of difficulty and staging, directed by students and presented in the professional theatre. The actor has the opportunity to put into practice with his/her peers, in a creative and experimental atmosphere, the principles and techniques developed in the classroom.
Prerequisites: 54-201 and 54-202.

54-313 Ballet III
Fall: 3 units
This course is dedicated to honing technical skills, expanding the classical dance vocabulary to the next level of difficulty, and addressing issues of strength, stamina, and endurance. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor
Prerequisites: 54-205 and 54-206.

54-314 Ballet III
Spring: 3 units
This course continues to hone technical skills, expand the classical dance vocabulary to the next level of difficulty, and address issues of strength, stamina, and endurance. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-313 and Permission of instructor
Prerequisite: 54-313.
Course Descriptions

54-315 Jazz III
Fall: 2 units
This course is to expand the versatility of the student dancer to master more complex exercises, in dynamics, direction and rhythm using Jazz styles examined by decades. Understanding the 20th century historical background of the 20’s, 30’s 40’s, 50’s 60’s and 70’s. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor. Prerequisites: 54-217 and 54-218.

54-316 Jazz III
Spring: 2 units
This course continues to expand the versatility of the student dancer to master more complex exercises, in dynamics, direction and rhythm using Jazz styles examined by decades. Understanding the 20th century historical background of the 20’s, 30’s 40’s, 50’s 60’s and 70’s. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-323 and Permission of instructor.

54-317 Singing for Actors III
Fall: 2 units
The students have a class voice experience which includes a physical and vocal warm-up and discussion of practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions. Prerequisites: 54-201 and 54-202.

54-318 Singing for Actors III
Spring: 2 units
The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions. Prerequisites: 54-201 and 54-202.

54-319 Cabaret
Fall: 6 units
The Art of Cabaret: Explores the use of Stories and Song to communicate life experiences within an intimate setting, breaking down the invisible fourth wall for honest communication. The course includes a section on the use of the microphone for singers. This study produces two Cabarets containing Material on a chosen Theme to provide hands-on Song Expression in a public forum. Prerequisite: 54-220.

54-321 Acting III for Directors
Fall: 9 units
An examination of various directing styles with particular attention to: verse forms including Greek and Elizabethan, comedy/ farce texts and Early 20th century styles including Ibsen and Shaw. On occasion, guest directors for our main-stage productions will be engaged to teach the style of the production that they are presently working on. Alternately, there is the possibility of this semester being used for an applied internship with a major producing organization. Prerequisites: 54-101 and 54-201.

54-322 Directing III: Forms and Formats
Spring: 9 units
This two-semester class for 3rd-Year Directors is directly related to the work in Directing 3/Acting Lab 2. The Seminar consists of organizational meetings, lectures & discussions relevant to the current class work — such as ground planning, rehearsal organization, vision, genre differentiation, new formats, working with actors, etc.

54-323 Tap III
Fall: 2 units
This course expands tap vocabulary and clear precision of execution through moderately difficult and extended combinations. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor. Prerequisites: 54-223 and 54-224.

54-324 Tap III
Spring: 2 units
This course continues to expand tap vocabulary and clear precision of execution through moderately difficult and extended combinations. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-323 and Permission of instructor. Prerequisite: 54-323.

54-325 Actor Dance III
Fall: 2 units
This course uses basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns. Course closed: Only for Acting majors in Drama. Prerequisite: Permission of instructor. Prerequisites: 54-201 and 54-202.

54-326 Actor Dance III
Spring: 2 units
This course continues to use basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns. Course closed: Only for Acting majors in Drama. Prerequisite: 54-325 and Permission of instructor. Prerequisites: 54-201 and 54-202.

54-330 Introduction to Stage Management
Spring: 6 units
This course is intended to provide students an opening to the knowledge and skills of the professional stage manager. It will also illuminate the qualities of a good stage manager specific to personality and human interaction. Within this course we will examine the role of the stage manager throughout the full scope of creating a production, including preparatory work, rehearsal period, technical rehearsal, performance and closing.

54-331 Explorations in Scenic Design
Fall: 9 units
Students will spend the year in an exciting and intensive exploration of the process of Scene Design as well as an examination of the nature of creativity and storytelling. Students will also engage extensively in the skills a professional Scene Designer requires, such as drafting, drawing, model making, painting and general collaborative skills. Students will be expected to deal with in-depth research, scriptural examinations, careful arrangements of space, composition and groundplan, conceptual structure, real life obstacles and the elements of a successful final project. By the end of this course, students will have improved their overall design skills, have some projects they can include in their portfolio and have created new routes toward their creativity. (pre-req, intro to Scene Design).

54-332 Scenic Design 1
Spring: 9 units
A continuation of the fall semester of Scene Design One. There will be added emphasis on collaboration during the spring semester. Concentration on the design process, the director-designer relationship, and the refinement of conceptual development will be highlighted. Prerequisite: 54-250.

54-333 Production Personnel Management
Fall: 6 units
Study of the management of production personnel for live theatrical productions. In-depth analysis of union contracts from a management perspective: AEA, IATSE, USA. Projects in scheduling and budgeting based on those contracts. Study of hiring, evaluating, and retaining a quality staff. Examination of the role of safety protocols in production. The Course concentrates on the relationship between the Production Manager and all of the personnel that one comes in contact with.

54-334 Production Resource Management
Spring: 6 units
This course examines the management of resources for the production of live theatrical productions. We start with analysis of scripts, to find the foundation for resource allocation. Then we move on to study the allocating two of the largest production resources: time and money. A significant exploration of the tracking of time and money extends throughout the course, with half of the class sessions taking place in a computer cluster, where we concentrate on advanced application of Excel, Access, and specialized calendar software.

54-337 Advanced Scenic Painting
Fall: 4 units
This is a year long course designed to explore more complex scene painting skills and techniques with an emphasis on professional standards. Projects in the first semester will address such topics as: translucency, tromp l’iel, aging, signage, perspective, carving and texture techniques. The second semester of this course is devoted to the generation and completion of an independent semester long project that explores skills and topics of the students’ choosing. Prerequisites: 54-237 or 54-238.
54-338 Scenic Painting 2
Spring: 6 units
This is a year long course designed to explore more complex scene painting problems with an emphasis on professional standards. Projects in the first semester will address such topics as: transluency, trompe l’oeil, aging techniques, signage, perspective, and working 3 dimensionally. Adequate mastery of skills in the first semester will permit more freedom in the second semester to do independent projects or group projects for public display.
Prerequisites: 54-237 and 54-238 and 54-337.

54-339 Stage Management Seminar
Fall: 3 units
This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-340 Stage Management Seminar
Spring: 3 units
This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-341 Costume Design I
Fall: 9 units
Portfolio Review and special permission required. Description: A two semester course that engages students with Susan Tsu and guest designers. Principals and elements of design including color theory are examined in discreet costume projects with a strong orientation toward process. Television Workshop with CMU alumni annually. Final project covers play analysis, research, emotional response, deconstruction of script, character analysis, awareness of all design disciplines, drawing, painting, swatching, and spec sheets. Students participate in Design Workshops such as the annual Dance/Light/Costume production design. Prerequisites: Drawing For The Theatrical Designer & Figure Drawing may be taken in the same year. Prerequisite: 54-162.

54-342 Costume Design I
Spring: 9 units
Portfolio Review and special permission required. A two semester course that engages students with Susan Tsu and guest designers. Principals and elements of design including color theory are examined in discreet costume projects with a strong orientation toward process. Television Workshop with CMU alumni annually. Final project covers play analysis, research, emotional response, deconstruction of script, character analysis, awareness of all design disciplines, drawing, painting, swatching, and spec sheets. Students participate in Design Workshops such as the annual Dance/Light/Costume production design. Prerequisites: Drawing For The Theatrical Designer & Figure Drawing may be taken in the same year. Prerequisites: 54-246 and 54-348.

54-343 Costume Construction I
Fall
FOR: Drama sophomores and juniors. This hands on practical application course is a study of primary construction principals with emphasis on the development of patterns from the basic costume shapes through history. Primary shapes first semester include men’s and women’s multi-piece bodices, historic sleeve shapes, breeches and skirts. The ability to look at a picture and interpret it to create the shape in fabric is stressed. Second semester, draping, boots and millinery are explored with some garments patterned for departmental productions. Techniques for communicating with the designer and fitting the actor are developed.

54-344 Costume Construction I
Spring: 6 units
FOR: Drama sophomores and juniors. This hands on practical application course is a study of primary construction principals with emphasis on the development of patterns from the basic costume shapes through history. Primary shapes first semester include men’s and women’s multi-piece bodices, historic sleeve shapes, breeches and skirts. The ability to look at a picture and interpret it to create the shape in fabric is stressed. Second semester, draping, boots and millinery are explored with some garments patterned for departmental productions. Techniques for communicating with the designer and fitting the actor are developed.

54-346 Introduction to Costume Construction
Spring: 4 units
For: Declared Costume Design Sophomores Students will build on the skills developed in stagecraft and on Costume crews from their first year. Emphasis will be placed on refining construction skills and learning finishing techniques. Students will also be provided with the skills necessary to perform successfully and safely as an assistant to a crew head.

54-347 Figure Drawing I
Fall: 4 units
This is a one semester course and is a PRE-REQUISITE for Figure Drawing II. Enrollment priority is given to Costume Design majors, then Design majors. This course will explore the realistic and expressive depiction of the human form. Students will work from live models each week, addressing such topics as anatomy and structure, gesture and movement, proportion and composition and individual expression. A variety of 2-dimensional media will be explored, as well. This course is designed to give students a solid grounding in their understanding of the human form and to increase their facility and confidence in drawing it accurately and expressively.

54-348 Figure Drawing I
Spring: 6 units
PRE-REQUISITES: One semester of 54-347 Figure Drawing I. DESCRIPTION: This year long course explores the realistic and expressive depiction of the human form, primarily in two dimensional media. Students will work from nude, draped and clothed live models, and will explore various media and formal approaches to the figure. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-349 Automated Lighting Technology
Spring: 6 units
Students are exposed to a range of automated lighting equipment and develop skills in the implementation of them in a production situation. Programming of automated fixtures on a variety of consoles is emphasized. Pre-requisites: Prerequisites: 54-351
Prerequisites: 54-351 and 54-352.

54-350 Introduction to Media Design
Spring: 9 units
Students become familiar with pre-visualization software programs as a tool for problem solving design issues and communicating design intent. Programs may include WYSIWYG, Visionary, ESP Vision and Martin Show Designer. Prerequisite: 54-252.

54-351 Theatrical Lighting Design
Fall: 9 units
The student’s ability to analyze and translate information in the script to descriptive stage pictures is developed in a more in-depth process. Verbal, written and visual communication of ideas is emphasized and explored through texts and lab work. Issues of collaboration with the director and other members of the design team are discussed as part of the design process. Prerequisites: 54252
Prerequisite: 54-252.

54-353 Structural Design I
Fall: 9 units
Required for all senior undergraduate Technical Direction students. A concentrated training in Structural Design specifically developed for the theater technician. This course teaches the process of Allowable Stress Design for the engineering of scenic structures in wood and steel. Drama majors only, or with instructor permission.

54-354 Structural Design II
Spring: 9 units
Required for all senior undergraduate Technical Direction students. Upon completion of this two-semester sequence, students are familiar with beam and column design/specification, truss design, tensile systems and structural connections. Prerequisite: 54-353.

54-355 30 Hour Osha
Fall: 6 units

54-356 Stage Management TV Project
Fall: 3 units
54-357 Directing: Production III  
Fall: 12 units  
Assignments as stage manager or assistant director for the Studio and Kresge Theatres.

54-358 Directing: Production III  
Spring: 12 units  
Assignments as stage manager or assistant director for the Rauh Studio and Chosky Theatres.

54-359 Stage Management and Actors Equity  
Fall: 3 units  
This class provides an in-depth exploration of Actors Equity Association and work rules for actors and stage managers. Through careful reading of contracts and guidelines, we will gain an understanding of current practice and the stage manager’s place within it. The class will also study related unions and current issues affecting the theatre.

54-361 Production Preparation III  
Fall

54-362 Production Preparation III  
Spring

54-363 Dramaturgy 5: Devised and Documentary Theatre  
All Semesters: 9 units  
Prerequisites: 54-109 and 54-184.

54-364 Dramaturgy 6: Advanced Topics  
Intermittent: 9 units  
Prerequisite: 54-184.

54-365 Machine Design I  
Fall: 9 units  
Required for all senior undergraduate Technical Direction students. In this course, concepts from Physics of Stage Machinery are applied to the specification, selection, design and assembly of real-world mechanical components for the realization of winches, turntables, wagons and lifts for theatrical use. Drama majors only, or with instructor permission.  
Prerequisite: 54-366.

54-366 Physics of Stage Machinery  
Spring: 9 units  
Required for all junior undergraduate PTM students. This is a one-semester pure Physics class designed to give theater technicians a base knowledge of Newtonian Physics, a pre-requisite for later courses in Machine Design. For this course, I have obtained special permission to use an unpublished text by Alan Hendrickson of the Yale University school of Drama. Drama majors only, or instructor permission.

54-367 Lighting Design Skills  
Fall: 2 units  
Students will concentrate on developing the skills necessary for lighting designers to successfully implement their designs in the theatre. Content includes communication, CAD programs, paperwork, focusing the show, programming conventional and moving light consoles, cue writing and expectations and responsibilities of the design assistant. This class meets during weeks 1-5 of the fall 2011 semester.

54-368 Production Electrics  
Spring  
Class content includes practical skills in lighting and electrical theory and practice as it pertains to entertainment lighting as well as development of managerial techniques used by Production Electricians in the industry. Students completing the class satisfactorily will be prepared for Master Electrician assignments on School of Drama productions as well as similar positions outside of the School. Co-requisite: 54-252.

54-373 Drawing for Theatrical Designers  
Fall: 9 units  
A semester-long basic drawing course taught by Susan Tsu focusing on developing hand-eye coordination, approaches to seeing and translating what the student sees onto the page free from preconceived notions and old habits. Discrete exercises allow the student many entry points into drawing. Developed for Theatrical Design students, accurate drawing of proportion is also a focus. Marker and pencil use only, Instructor permission and an interview/portfolio review required. This course is for School of Drama Design/PTM majors.

54-376 Entertainment Rigging  
Spring: 3 units  
This course is a survey of the techniques and practices of theatrical rigging. The course has two main components: permanently installed rigging systems typically found in theatres, and background and technical information concerning the components typically used for stage rigging. Discussion topics include selection criteria for line, hardware, and terminations stressing entertainment industry standards, workplace safety and common industry misconceptions. Time permitting the course will shift from a general discussion of components to their assembly into custom rigging systems & solutions. Instructor’s permission only.  
Prerequisite: 54-477.

54-378 Technical Direction II  
Spring: 9 units  
This course is an exploration of techniques and practices of Technical Designers. The class has four main components: an exploration of the types of strategies used by Technical Designers to arrive at solutions, building an expert vocabulary for discussion of technical design issues, development of actual technical solutions, on paper, in discussion, and in the shop, discussion of any pertinent technical issues for any of the school productions while in development. Prerequisites/Co-requisites: Technical Direction or instructor’s permission  
Prerequisite: 54-273.

54-379 2D Scenic Design Skills  
Fall: 6 units  
Students explore a variety of two dimensional media and techniques as they pertain to building ideas for the Scene Designer. Students will investigate drawing, watercolor, gouache, acrylics, drafting, rendering, basic thumbnails, paint elevations and markers.

54-380 Music Reading for Drama Technicians  
Spring: 3 units  
This class gives the basics of music theory, musical terminology and score reading. Students focus on the difference in various musical scores, i.e. piano/vocal, full, hand written scores. Students are guided in classroom listening which a wide variety of music including, opera, musical theatre, ballet, and choral/orchestra works.

54-381 Special Topics in Drama: History, Literature and Criticism  
Fall and Spring: 6 units  
Every semester, members of the School of Drama’s faculty offer seminars on special topics that investigate some aspect of theatre history, dramatic literature, dramatic theory, or a particular author, period, or genre. Like all Dramatic Literature classes, these are academically rigorous, requiring some amount of intensive critical reading and writing. Registration for this course is limited to Drama majors.

54-382 History of Drama  
Fall and Spring: 3 units  
Every semester, members of the School of Drama’s faculty offer seminars on special topics that investigate some aspect of theatre history, dramatic literature, dramatic theory, or a particular author, period, or genre. Like all Dramatic Literature classes, these are academically rigorous, requiring some amount of intensive critical reading and writing. Registration is limited to Drama majors.

54-386 Scenic Design Skills  
Spring: 4 units  
Students explore a variety of three dimensional media and techniques as they pertain to building ideas for the Scene Designer. Students will investigate many aspects of model building, from basic structural ideas to complex organic and architectural forms, furniture, and advanced techniques such as metal work. Students will also work in depth with the concepts of working in three dimensional space through ideas of scale and layering.  
Prerequisite: 54-231.

54-387 Dramaturgy I: Production I  
Fall  
Working as a production dramaturg for a senior thesis or grad show, or as an assistant dramaturg for a season show, in junior year.

54-388 Dramaturgy: Production I  
Spring  
Working as a production dramaturg for a senior thesis or grad show, or as an assistant dramaturg for a season show, in junior year.
54-389 Growing Theatre Community Outreach
Fall: 9 units
Growing Theatre engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theatre uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students’ personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU's.

54-390 Growing Theatre Community Outreach
Spring: 9 units
Growing Theatre engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theatre uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students’ personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU's.

54-393 My True Voice
Fall: 6 units
This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry.

54-394 My True Voice
Spring: 6 units
This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry and participate in a presentation for family and friends using the skills they have learned.

54-397 Special Topics in Sound Design
Fall: 9 units
Prerequisites: 54-267/268 Sound Design I. Drama majors have priority, however this course is also open to Music Technology majors and minors, or with permission of instructor. Prerequisites: 54-267 or 54-268.

54-398 Special Topics in Sound Design
Spring: 9 units
Prerequisites: 54-267 and 54-268.

54-399 Decoding Media
Fall: 9 units
Decoding Media: Based in the analysis of several plays, students learn media basics for the theatre, from creating their own media by shooting with small cameras and editing in widely available programs to the presentation of media in a variety of formats. The class takes students through the process of initial creative brainstorming, to communication tools (concept sketches, digital renderings, 3D models), onto projection optics and final design presentations. For Juniors, Seniors and Grads. No Prerequisite Open to non-majors.

54-401 Camera Lab
Fall: 3 units
This is a year long course required for senior undergraduate directing and acting majors and second year graduate directors. The students are introduced to some fundamental ideas about story telling with a camera. The students learn and practice both single and multi-camera techniques. There are a series of projects for the students to encounter and practice acting, directing, and designing for the camera. Prerequisite: 54-302.

54-402 Camera Lab
Spring: 3 units
Advanced scene study: selectivity, clarity; the honing of performance techniques. Professional requirements, the practical extension of the training. Audition and TV techniques. Preparation for a New York presentation at the end of the Spring semester.

54-403 Voice Over Acting
Fall: 3 units
(Voice) The senior actors continue to strengthen their voice work with individualized voice classes and tutorials. The voice work often addresses particular issues, which these actors encounter in the mainstage productions. Students also re-visit classical text work and build on their sophomore year preparation with additional Shakespeare material. The pieces are prepared as professional audition selections in this work. (Voice-Over Acting) A commercial aspect of the voice work is introduced, developed and marketed in the Voice-Over Acting class. The course presents information which is then applied to narrating radio and television commercials, industrials, feature-length animations, books on tape, CD-ROM videos, computer software programs, etc. Texts are developed for two demo tapes, which are prepared in class and readied for a professional studio-taping session.

54-404 Voice Over Acting
Spring: 6 units
(Voice) The senior actors continue to strengthen their voice work with individualized voice classes and tutorials. The voice work often addresses particular issues, which these actors encounter in the mainstage productions. Students also re-visit classical text work and build on their sophomore year preparation with additional Shakespeare material. The pieces are prepared as professional audition selections in this work. (Voice-Over Acting) A commercial aspect of the voice work is introduced, developed and marketed in the Voice-Over Acting class. The course presents information which is then applied to narrating radio and television commercials, industrials, feature-length animations, books on tape, CD-ROM videos, computer software programs, etc. Texts are developed for two demo tapes, which are prepared in class and readied for a professional studio-taping session.

54-405 Future Stages for Undergrad Actors
Fall: 3 units
FUTURE STAGES is a graduate level course (Drama undergraduates by permission only) which combines options from the School of Drama in a new configuration: through working collaboratively across disciplines, students investigate multimedia approaches to contemporary theater and new ways of storytelling. Directors, designers, actors, and dramaturgs work in groups to generate original ideas, images, texts, and material in a workshop environment. These working groups create projects over the course of the semester which are shown in informal presentations. The emphasis is on process, not product — devising an interdisciplinary performance requires a keen focus on combining creative invention with a rigorous structure of concept development - - a course which are explored. We examine the work of several significant contemporary theater artists whose work approaches collaboration across a variety of disciplines. Artists have included: Ariane Mnouchkine, Dumbtype, Complicite, Ralph Lemon, Robert Leipziger, and more. Students learn to define and distinguish these artist’s approaches through viewing video excerpts, readings, and discussion. This class is an opportunity to explore avenues outside of traditional production modes and beyond each student’s individual discipline. We focus on the process of creating a theatrical language which truly integrates disciplines. Prerequisites: 54-301 and 54-302.

54-407 Movement IV
Fall: 4 units
Movement IV is a cross-option course, wherein sophomore Designers build masks for the Senior Actors to use in the creation of a movement/mask piece based on a classic text. (Examples: HEDDA GABLER, CAT ON A HOT TIN ROOF, DRACULA, CYRANO). The course gives Senior Actors an opportunity to create an original ensemble performance piece, bringing over 30 masks to life, using skills learned in the previous classes in mask work (Neutral Mask, Commedia dell’Arte, character and larval masks). Due to the necessity of working as an ensemble in the creation of this piece, the students must work together in various roles: as actors, of course, but also as directors, writers, dramaturgs and stage managers; this course offers a particular opportunity for actors and designers to work together to create masks which are able to be brought to life through movement, that are comfortable, offer enough visibility, are secure during activity, etc. – a unique learning laboratory for designers and actors to interact involving both artistic and practical issues related to the creation and use of these masks as theatrical metaphor. Prerequisites: 54-207 and 54-208.
54-408 Movement IV
Spring: 4 units
In the Senior year, students may study stage combat, including hand-to-hand, quarterstaff, and single rapier, leading to scene work incorporating these skills. Other studies might include dramatic acrobatics, circus skills, and Eastern disciplines such as yoga, Tai Chi, etc. Focus on personal physical style; application of movement training on the mainstage in performance. Prerequisites: 54-207 and 54-208.

54-409 Theatre Lab for Undergraduates
Fall
This is a two-semester class which teaches the collaborative process of theatre — including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This work results in 10-minute play scripts, one act, monologue dramas, and the texts for the MFA Thesis Productions. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options.

54-410 Theatre Lab for Undergraduates
Spring
This is a two-semester class which teaches the collaborative process of theatre — including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options. Prerequisite: 54-409.

54-411 Acting Symposium IV
Fall: 18 units
Participation outside of class requirements in departmental productions. Putting into practice the techniques acquired over the years of training and exploring the development of a performance played before the public over two weeks. Prerequisites: 54-311 and 54-312.

54-412 Acting Symposium IV
Spring: 18 units
Participation outside of class requirements in departmental productions. Putting into practice the techniques acquired over the years of training and exploring the development of a performance played before the public over two weeks. Prerequisites: 54-311 and 54-312.

54-413 Showcase
Fall: 4 units
Senior acting class for actors and Mt’s who are in good standing and in position to graduate in the Spring. Preparation for the New York and Los Angeles Showcase presentations. Prerequisites: 54-301 and 54-302.

54-414 Showcase
Spring: 9 units
Senior acting class for actors and Mt’s who are in good standing and in position to graduate in the Spring. Preparation for the New York and Los Angeles Showcase presentations. Prerequisites: 54-301 and 54-302.

54-415 Broadway Styles
Fall: 4 units
This course is designed to provide the student with a practical and historical knowledge of the dance repertoire in American Musical Theater using the original choreography from prominent Broadway choreographers. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor. Prerequisite: 54-319.

54-416 Broadway Styles
Spring: 4 units
This course continues to provide the student with a practical and historical knowledge of the dance repertoire in American Musical Theater using the original choreography from prominent Broadway choreographers. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-415 and Permission of instructor. Prerequisite: 54-319.

54-422 Directing IV
Spring: 6 units
Encounter major 20th century theatrical and dramatic movements. Specific concentration on directorial innovations in the last half of the 20th century.

54-423 Tap IV
Fall: 2 units
This course presents advance tap vocabulary and challenges the ability of the student to master advanced repertoire at a consistent professional level. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor. Prerequisites: 54-323 and 54-324.

54-424 Tap IV
Spring: 2 units
The course continues to present advance tap vocabulary and challenges the ability of the student to master advanced repertoire at a consistent professional level. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-423 and Permission of instructor. Prerequisite: 54-423.

54-431 Scenography
Fall: 9 units
The first semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Disciplines of conceptualization, collaboration and communication are explored and engaged. Prerequisites: 54-331 & 54-332. Prerequisite: 54-331.

54-432 Scenic Design II
Spring: 9 units
The second semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Disciplines of conceptualization, collaboration and communication are explored and engaged. Prerequisite: 54-431.

54-437 Acting IV
Fall: 5 units
An integration of training and craft approaches related to the rehearsal process featuring a comprehensive approach to text. Students will also examine their propensities and limitations in order to expand their emotional physical vocal and intellectual range. Prerequisites: 54-301 and 54-302.

54-438 Acting IV
Spring: 3 units
An integration of training and craft approaches related to the rehearsal process featuring a comprehensive approach to text. Students will also examine their propensities and limitations in order to expand their emotional physical vocal and intellectual range. Prerequisites: 54-301 and 54-302.

54-439 Stage Management Seminar
Fall: 3 units
This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-440 Stage Management Seminar
Spring
This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-441 Costume Design II
Fall: 9 units
Portfolio Review and special permission required. Description: For the advanced Costume Designer. A two semester course that engages students with Susan Tsu and guest designers. Focused on a range of playwrights and theatre genres- Moliere, Musical Theatre, Brecht, Shakespeare, International and Contemporary pieces are researched and designed. Special attention paid to process, research, nuts and bolts and the honing of each designer's skills. Prerequisites: Drawing For The Theatrical Designer, Intro to Costume Design, Costume Design I. History of Clothing and Figure Drawing can be taken simultaneously. FOR: Second year graduate costume majors and Senior undergraduates with declared majors. Prerequisites: 54-245 and 54-341 and 54-347.
54-442 Costume Design II  
Spring: 9 units  
Portfolio Review and special permission required. Description: For the advanced Costume Designer. A two semester course that engages students with Susan Tsu and guest designers. Focused on a range of playrights and theatre genres- Molieres, Musical Theatre, Brecht, Shakespeare, International and Contemporary pieces are researched and designed. Special attention paid to process, research, nuts and bolts and the honing of each designer’s skills. Prerequisites: Drawing For The Theatrical Designer, Intro to Costume Design, Costume Design I. History of Clothing and Figure Drawing can be taken simultaneously. FOR: Second year graduate costume majors and Senior undergraduates with declared majors. Prerequisites: 54-246 and 54-448.

54-443 Costume Construction II  
Fall: 6 units  
FOR: All Costume Majors have priority. Advanced problems in costume building and pattern development are individually assigned to strengthen the skills of the student. Projects may be drawn from actual designs for productions if the challenge is suitable for the student’s development. This course may be taken for 1 or 2 semesters, starting either Fall or Spring PRE-REQUISITES: Both semesters of Costume Construction I  
Prerequisites: 54-343 and 54-344.

54-444 Costume Construction II  
Spring: 6 units  
FOR: All Costume Majors have priority. Advanced problems in costume building and pattern development are individually assigned to strengthen the skills of the student. Projects may be drawn from actual designs for productions if the challenge is suitable for the student’s development. This course may be taken for 1 or 2 semesters, starting either Fall or Spring PRE-REQUISITES: Both semesters of Costume Construction I  
Prerequisites: 54-343 and 54-344.

54-445 Professional Preparation  
Fall: 3 units  
A brief introduction for design-oriented pre-professionals to the issues, challenges and conventionally-held practices of responsible self-employment. Specific issues and problem-solving skills will be introduced through lectures, discussions and handouts. No testing or project work outside of class is anticipated for the successful completion of this course. Prerequisite: open to Seniors only.

54-447 Figure Drawing II  
Fall: 4 units  
PRE-REQUISITES: If taking Figure Drawing II, both semesters of Figure Drawing I FOR: Costume Majors have priority, then Design Majors. First experience should be in Zamborsky section. DESCRIPTION: This year-long course explores the realistic and expressive depiction of the human form primarily in two dimensional media. Working primarily from the life model, exercises will be undertaken that address gesture, proportion, movement, anatomy and structure, composition and expressive form. Students will experience a variety of media and formal approaches to the figure, working from nude, draped, and clothed male and female models. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-448 Figure Drawing II  
Spring: 6 units  
PRE-REQUISITES: If taking Figure Drawing II, both semesters of Figure Drawing I FOR: Costume Majors have priority, then Design Majors. First experience should be in Zamborsky section. DESCRIPTION: This year-long course explores the realistic and expressive depiction of the human form primarily in two dimensional media. Working primarily from the life model, exercises will be undertaken that address gesture, proportion, movement, anatomy and structure, composition and expressive form. Students will experience a variety of media and formal approaches to the figure, working from nude, draped, and clothed male and female models. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-450 Painting for the Theatrical Designer  
Spring: 6 units  

54-451 Architectural Lighting Design  
Fall: 9 units  
Prerequisites: 54-349 and 54-350 and 54-352.

54-453 Production Management Workshop I  
Fall: 3 units  
Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Course is discussion based on 1) participants experience in laboratory productions in the School of Drama, 2) current practical examples of experiences of professional production managers, and 3) contemporary management texts. Topics covered include: Budgeting, Scheduling, Communication, and Project Management. Permission of instructor required.

54-456 Production Management Workshop  
Spring: 3 units  
Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Course is discussion based on 1) participants experience in laboratory productions in the School of Drama, 2) current practical examples of experiences of professional production managers, and 3) contemporary management texts. Topics covered include: Budgeting, Scheduling, Communication, and Project Management. Permission of instructor required.

54-457 Directing: Production IV  
Fall: 12 units  
SENIOR DIRECTING PROJECT: This is a 90-minute, public, fully-designed presentation directed by a 4th-Year Directing student with the following goals: to publicly realize a playwright’s purpose for a live audience; to tell an entire theatrical story with a beginning, progression & ending; to work as a team with actors & design team to shape a cohesive & coherent theatrical presentation; to extend practical understanding of Theatre as a collaborative process; to synthesize & apply prior studies at Carnegie Mellon.

54-458 Directing: Production IV  
Spring: 10 units  
SENIOR DIRECTING PROJECT: This is a 90-minute, public, fully-designed presentation directed by a 4th-Year Directing student with the following goals: to publicly realize a playwright’s purpose for a live audience; to tell an entire theatrical story with a beginning, progression & ending; to work as a team with actors & design team to shape a cohesive & coherent theatrical presentation; to extend practical understanding of Theatre as a collaborative process; to synthesize & apply prior studies at Carnegie Mellon.

54-459 Future Stages for Undergrad Directors and Dramaturgs  
6 units  
FUTURE STAGES is a graduate level course (Drama undergraduates by permission only) which combines options from the School of Drama in a new configuration: through working collaboratively across disciplines, students investigate multimedia approaches to contemporary theater and new ways of storytelling. Directors, designers, actors, and dramaturgs work in groups to generate original ideas, images, texts, and material in a workshop environment. These working groups create projects over the course of the semester which are shown in informal presentations. The emphasis is on process, not product — devising an interdisciplinary performance requires a keen focus on combining creative invention with a rigorous structure of concept development — both of which are explored here. We also examine the work of several significant contemporary theater artists whose work approaches collaboration across a variety of disciplines. Artists have included: Ariane Mnouchkine, Dumbtype, Complicite, Ralph Lemon, Robert LePage, and more. Students learn to define and distinguish these artist’s approaches through viewing video excerpts, readings, and discussion. This class is an opportunity to explore avenues outside of traditional production modes and beyond each student’s individual discipline. We focus on the process of creating a theatrical language which truly integrates disciplines. Prerequisite: 54-222.
54-460 Future Stages for Undergrad Designers
Fall: 6 units
FUTURE STAGES is a graduate level course (Drama undergraduates by permission only) which combines options from the School of Drama in a new configuration; through working collaboratively across disciplines, students investigate multimedia approaches to contemporary theater and new ways of storytelling. Directors, designers, actors, and dramaturgs work in groups to generate original ideas, images, texts, and material in a workshop environment. These working groups create projects over the course of the semester which are shown in informal presentations. The emphasis is on process, not product — devising an interdisciplinary performance requires a keen focus on combining creative invention with a rigorous structure of concept development — both of which are explored here. We also examine the work of several significant contemporary theater artists whose work approaches collaboration across a variety of disciplines. Artists have included: Ariane Mnouchkine, Dumbtype, Complicite, Ralph Lemon, Robert LePage, and more. Students learn to define and distinguish these artist’s approaches through viewing video excerpts, readings, and discussion. This class is an opportunity to explore avenues outside of traditional production modes and beyond each student’s individual discipline. We focus on the process of creating a theatrical language which truly integrates disciplines. Prerequisite: 54-231.

54-461 Production Preparation IV
Fall
Participation in School of Drama productions, usually in supervisory roles in design or production. Prerequisites: 54361 and 54362
Prerequisites: 54-361 and 54-362.

54-462 Production Preparation IV
Spring
Participation in School of Drama productions, usually in supervisory roles in design or production. Prerequisites: 54361 and 54362
Prerequisites: 54-361 and 54-362.

54-463 Dramaturgy Research Hours
Fall and Spring

54-464 PTM Professional Practice
Spring: 3 units

54-466 Advanced Media Design II
Spring: 2 units
This is a laboratory experience designed to give practical experience implementing standard stage machinery in a production context. Specific content is dependent on the needs of current productions. Prerequisites: 54-350 and 54-465.

54-469 Dance Lighting Design
Fall: 2 units
This class meets during weeks 8-15 of the fall 2011 semester.

54-475 Theatre Management
Fall: 6 units
Survey of management practices and principles as applied to the performing arts. Investigation of selected problems typical of those facing the arts administrator.

54-477 Technical Direction III
Fall: 6 units
Required for all senior undergraduate Technical Direction students. This “capstone” course is the second semester of a sequence requiring application of concepts from earlier courses including Standard Scenery Construction, Production Planning, Structural Design, Stage Machinery Design and Technical Design 1. This is a project-based course requiring weekly presentation of solutions to various “unusual” technical challenges, drawn from actual production experiences. Thorough documentation (shop drawings, budgets, build schedules, etc.) is a requirement for each project. Prerequisite: 54-378.

54-478 Television Lighting Design
Fall: 1 unit
This class meets during weeks 5-7 of the fall 2011 semester.

54-480 Technical Direction IV
Spring: 6 units
This class gives the basics of music theory, musical terminology and score reading. Students focus on the difference in various musical scores, ie. piano/vocal, full, hand written scores. Students are guided in classroom listening which a wide variety of music including, opera, musical theatre, ballet, and choral/orchestra works. Prerequisite: 54-477.

54-487 Dramaturgy: Production II
Fall
Working as a production dramaturg for a season show or a professionally-produced show at a LORT or similarly-ranked theatre in the US or abroad, in senior year.

54-488 Dramaturgy: Production II
Spring
Working as a production dramaturg for a season show or a professionally-produced show at a LORT or similarly-ranked theatre in the US or abroad, in senior year.

54-489 Dramaturgy: Internship
Fall: 9 units
Professional internship with a dramaturg at a LORT or similarly-ranked theatre in the US or abroad.

54-490 Dramaturgy: Internship
Spring: 9 units
Professional internship with a dramaturg at a LORT or similarly-ranked theatre in the US or abroad.

54-491 Concert Lighting Design
Fall: 9 units

54-493 Business of Acting
Fall: 4 units
This course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts, New York and regional theater season, s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons. Registration for this course is limited to Drama majors only. Prerequisites: 54-301 and 54-302.

54-494 Business of Acting
Spring: 3 units
The course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts, New York and regional theater season, s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons. Prerequisites: 54-301 and 54-302.

54-499 Advanced Digital Image
Intermittent: 6 units
Advanced Digital Image: (Mini) This class is designed to teach students how to conceive, create and present large scale, professional-quality imagery at “realistic” budget levels. Students choose specific theatrical scenes and create a media based solution for them. Through in-class workshops and Media Lab work-time, this class covers High Definition video production, editing, animation & live video systems for the stage as well as a variety of media-server based presentation technologies. For Juniors, Seniors and Grads. No Prerequisite Open to non-majors.

54-500 Voice Lab
Fall and Spring: 5 units
Singing Voice based on speech-level and classical singing techniques, required of all Musical Theatre Majors Lessons are private, for the duration of one hour per week. Voice Lab combines all students of Musical Theatre in a one-hour performance class, where repertoire is performed for faculty and students alike. Training is progressive, with each semester building on the vocal mastery achieved from the previous semester. Repertoire spans from classical to rock, but with an emphasis on songs extracted from the American Musical Canon.

54-505 Ear Training
Fall: 1 unit
Ear Training for sound designers and audio technologists. Introduction and development of skills and techniques for discerning, measuring and expressing the physical qualities of sound with accuracy and sensitivity. Topics include recognizing frequencies (1/3 octave and dual-octave) and analyzing effects and processing (pitch, amplitude, time domain and timbral). This course is open to Drama Sound Design majors or Drama minors, Music Technology major/minors, ETC students, or permission of instructor.
54-509 Advanced System Design
Fall: 9 units
Intensive course exploring the theory, art and technology of large scale sound system design for entertainment, specifically live theater productions. Prerequisites: 54-166 or 54-766 Intro to Sound Design for Theatre, and 54-666 Production Audio, OR permission of instructor. Prerequisites: 54-166 and 54-666.

54-511 Millinery I
Fall: 6 units
Drama majors only, and costume design students have priority.

54-517 Director's Colloquium
Fall: 1 unit
54-518 Director's Colloquium
Spring: 1 unit

54-519 Acting for the Camera
6 units
Prerequisite: 54-302.

54-520 Acting for the Camera
Fall and Spring: 9 units
This course is for senior acting and music theatre majors only. Prerequisite: 54-302.

54-525 Electrics Seminar
Fall
Course content includes advanced techniques in the management of a lighting department and continued practical application of the same. Class meetings will be in a seminar format as well as individual sessions with the instructor. An assignment on a School of Drama production is an integral part of the course. Prerequisites: 54-368.

54-527 Automated Lighting Workshop
Fall
Fall: mini sessions 3-9 units Students will explore the operation of various automated lighting equipment in a hands-on format. An assignment on a School of Drama production may be included as part of the course. This course is repeatable. Prerequisites: 54-351.

54-560 Interactive Technology and Live Performance
Spring: 10 units
This studio course considers the performance skills, design aesthetics, and technical issues unique to effective communication in digital and networked storytelling and performance environments. Through weekly projects, students will develop skills in working with and/or creating a wide range of technologies for stage, film, video, the internet, and performance art, including: systems for motion capture and CG avatars; voiceover and ADR; remote direction and teleprompting; interactive lighting, projections, and costumes; improvisation with synthetic (AI) agents; and distributed systems for coordinating large-scale participatory events in the public sphere. In so doing, the course explores the ways in which these technologies are changing our understanding of the actor’s body and shifting the nature of performance itself.

54-666 Production Audio
Spring: 6 units
Introduction to the technology and theory of sound systems, specifically those as they are utilized in theatrical and other live entertainment productions.

54-721 Graduate Directing: Text to Stage
Fall

54-722 Graduate Directing: Text to Stage
Spring

73-100 Principles of Economics
All Semesters: 9 units
Literally, an introduction to economic principles, the goal of this course is to give students an understanding as to what constitutes good “economic thinking”. This thought process is grounded in the construction and use of economics models. Drawing on issues in both microeconomics and macroeconomics, fundamental principles are shown to transcend particular examples and allow the field to be seen as a coherent, unified whole. (Lecture, 2 hours; Recitation, 1 hour).

73-101 Freshman Seminar
Fall and Spring: 9 units
A topics-based course for first-year students who intend to major in economics. The subjects discussed vary from year-to-year and from instructor-to-instructor. Check with the Undergraduate Economics Program or their website for descriptions of recent and current offerings. (Seminar, 3 hours).

73-111 Internship I
All Semesters
By permission of the Undergraduate Economics Program.

73-112 Internship II
All Semesters: 3 units
By permission of the Undergraduate Economics Program.

73-113 Internship III
All Semesters: 3 units
By permission of the Undergraduate Economics Program.

73-148 Environmental Economics
Spring: 9 units
A course for non-majors which explores the interplay between economic and environmental issues. Topics include: market failures and environmental problems, economically efficient allocations of environmental resources, and the intended and unintended consequences of public policies designed to improve the environment. Practical issues surrounding the feasibility of implementing theoretically efficient principles and policies are analyzed, and alternative policies that might achieve better results in practice are investigated. (Lecture, 3 hours).

73-230 Intermediate Microeconomics
Fall and Spring: 9 units
This course is a calculus-based introduction to microeconomics. Topics in partial equilibrium analysis include supply and demand, consumer theory, theory of the firm, profit maximizing behavior, monopoly theory, and perfect competition. The course concludes with an introduction to general equilibrium analysis and the welfare laws. (Lecture, 3 hours; Recitation, 1 hour). Minimum grade standard of "C" applies to only economics courses.

73-240 Intermediate Macroeconomics
9 units
Through macroeconomic models built upon microeconomic foundations, insights are developed into economic growth processes and business cycles. Topics include aggregation and measurement, national income, business cycle measurement, economic welfare theorems and social inefficiencies, the effect of government fiscal policy upon employment and productivity, and the relationship between investment, interest rates and economic growth. (Lecture, 3 hours; Recitation, 1 hour). Minimum grade standard of "C" applies to only economics courses.

73-252 Advanced Microeconomic Theory
Fall and Spring: 6 units
This course provides a mathematically intensive overview of advanced applications of microeconomic theory. Topics include: Marshallian and Hicksian demands, indirect utility functions, substitution/income effects and the Slutsky equation, expected utility theory, risk and insurance, game theory, principle/agent problems, oligopoly, and general equilibrium theory. (Lecture, 3 hours). Minimum grade standard of "C" applies to only economics courses.

73-262 Advanced Macroeconomic Theory
Fall and Spring: 6 units
This course provides a mathematically intensive overview of advanced applications of macroeconomic theory. Topics include: economic growth dynamics, business cycle behavior, inflation, money supply determination, and the natural rate of unemployment. (Lecture, 3 hours). Minimum grade standard of "C" applies to only economics courses.

Economics Courses

73-050 Study Abroad
All Semesters

73-051 Study Abroad
All Semesters
73-253 Advanced Macroeconomic Theory  
Fall and Spring: 6 units  
Mini II and Mini IV Fall and Spring, second mini-session: 6 units  
This course provides a mathematically intensive overview of advanced applications of microeconomic theory. Topics may include: Solow and neo-classical growth models, the role of money and its effect on the economy, and the overlapping generations model. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240) and (73-252).

73-270 Writing for Economists  
Fall and Spring: 9 units  
Fall or Spring A writing course specifically designed for third-year Economics majors and additional majors. Students gain experience with technical writing techniques and skills needed for both their senior thesis and their eventual professional careers. The course emphasizes both individual and group projects. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.  
Prerequisites: (76-101) and (73-100) and (73-230) and (73-240).  

73-310 Evolution of Economic Ideas and Analysis  
9 units  
This course will be organized around the study of several central topics in the development of economics such as: the "invisible hand," classical analysis of trade, value, and income distribution; the marginalist revolution; general equilibrium theory; classical monetary economics; Keynesian macroeconomics; and recent trends in theory and empirical analysis. Where possible, examination of the contemporary policy issues motivating major analytical developments will be included. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.  
Prerequisites: (21-120) and (21-259 or 21-256) and (73-100) and (73-230) and (73-240).

73-315 Market Design  
Fall: 9 units  
The market design class is going to cover three main subjects: matching, auctions, and, time allowing, marketplaces. Matching topics may include: Two-Sided Matching and Medical Residents House Allocation and Kidney Exchange School Choice Law Clerks and College Early Admission Auction/Marketplace topics may include: Designing Optimal Auctions Common Value Auctions Multi-Unit Auctions and Treasury Auctions Multi-Item Auctions and The Assignment Model Sponsored Search Auctions The FCC and Simultaneous Ascending Auctions Package Auctions and Radio Spectrum Introduction to the Economics of Platforms Internet Platforms: e-Commerce Internet Markets: Advertising  
Prerequisites: (21-120) and (21-259 or 21-256) and (73-100) and (73-230) and (73-240).

73-328 Health Economics  
Spring: 12 units  
This course will teach the student to use economic analysis to understand critical issues in health care and health policy. We will address issues such as the following: 1. What factors best explain the level and rate of growth of U.S. health expenditures? 2. Does the recent high rate of growth of U.S. health care expenditures make U.S. firms less competitive in international markets? 3. What are some of the likely consequences (intended and unintended) of the proposed reforms to Medicare? 4. Can physicians induce demand for their services? 5. What are the impacts of managed care on the health care system? 6. Do strong affiliations between physicians and health plans hurt competition? Learning Objectives: The student who successfully completes this course will be able to: 1. Identify the flow of resources in the U.S. health care system, how purchasers pay for their services, and how providers obtain their revenues. 2. Understand the value of health and health care. 3. Evaluate how health care resources should be allocated. 4. Describe the structure of the health insurance industry, explain the incentives facing insurers, understand the strategies they use to compete and their impacts on social welfare. 5. Understand the demand for medical care, and what role providers play in shaping this demand. 6. Explain the economics of managed care and describe how competition works in health care. Class will consist of lectures and group presentations. Evaluation will include homework problems, group projects, and exams. This course will interest any individual planning a career in health or related industries. It will also be of interest to students who wish to understand how economics is applied to some of our most prominent and contentious policy issues. No prior knowledge of health care is supposed. (Lecture, 4.5 hours). Minimum grade standard of "C" applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-331 Political Economy of Inequality and Redistribution  
Spring: 9 units  
Societies use welfare policies, social insurance, public employment, private charity, and of course, private labor markets to distribute the economic resources that they produce. The mixture of these programs varies tremendously across countries and over time. We will investigate the causes and consequences of the rich variety of strategies that have been used in industrialized democracies to address the problems of economic inequality and poverty. We will also investigate important economic challenges and debates in these countries. For example, we will study recent welfare reforms and tax cuts in the United States as well as current debates over the future of social security. We will also study the possible effects of globalization on domestic well-being and social policy. Throughout the course we will ask how political values and institutions might affect the choices made concerning these issues and challenges. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-340 Labor Economics  
Spring: 9 units  
This course uses economic theory and data to analyze topics such as: (1) individuals decisions about hours of work, investment in training or education, and choosing an occupation; (2) firms decisions about hiring, training workers, and setting wage rates; and (3) the resulting wage and employment outcomes as influenced by union contracts and implicit or explicit employment contracts. Also considered are public policy recommendations concerning minimum wages, job training programs, hazards on the job, race and sex discrimination, and income inequality. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-347 Game Theory for Economists  
Intermittent: 9 units  
An introduction to the theory of non-cooperative games with an emphasis on economic applications. After an initial examination of two-person, zero-sum games, the notion of a Nash equilibrium in an n-person, non-cooperative game is considered. Existence of and refinements to the equilibrium concept are discussed in the context of both normal and extensive form games. Economic applications may include various topics, including Cournot and Bertrand oligopoly models, general competitive exchange equilibrium, and free-rider problems. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-259 or 21-256) and (73-100) and (73-230).
73-351 Public Finance
Intermittent: 9 units
This course examines problems created by market failure and analyzes the incentives and institutions, which can be used to alleviate these problems. We will consider applications such as education, environmental issues, defense, crime, and common resources. The common thread in these situations is that individual optimizing behavior does not necessarily lead to an outcome, which is optimal for society. We will evaluate possible solutions involving private, informal mechanisms as well as those requiring public sector interventions. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-352 Public Economics
Spring: 9 units
Fall or Spring In this course, students analyze the role of governments in market economies and their impact on the behavior and welfare of citizens. Reasons for government intervention in markets are examined in light of some of the economic challenges faced by modern societies in an increasingly globalized marketplace. Topics include: taxation and expenditure policies, externalities and market failure, social security, public assistance and income redistribution programs. There will also be some coverage of the role of local governments in the economy with respect to such issues as crime, urban development and education. (Lecture, 3 hours).
Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-357 Regulation: Theory and Policy
Intermittent: 9 units
Government regulations touch almost every aspect of our lives—from our healthcare and work environments, right down to the food we eat and the air we breathe. Using an analytical framework that encompasses economic, political, and bureaucratic forces that create and shape them, this course explores the origins, goals, and implementation of many major regulations. Areas of regulation specifically examined might include air pollution, auto safety (air bags), food additives, technological risk (nuclear reactors), occupational safety (asbestos, cotton dust), hospitals, airlines and trucking, and consumer protection (truth in advertising). (Lecture, 3 hours)
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-358 Economics of the Environment and Natural Resources
Intermittent: 9 units
Fall or Spring A advanced course on the allocation of environmental and natural resources. Topics include: externalities and the misallocation of resources, examining the efficiency/inefficiency of markets for non-renewable resources, intended and unintended consequences of regulatory and tax policies, and modern alternative to regulation—such as the creation of property rights and property rights for environmental resources. (Lecture, 3 hours).
Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-359 Benefit-Cost Analysis
Fall: 9 units
The evaluation of public private sector projects. The theory of benefit-cost analysis and related techniques, such as cost-effectiveness analysis. Attention is given to such issues as valuing goods and services that are not normally traded in the marketplace (e.g., the value of an individuals life) and the social rate of discount. Applications are considered in detail. (Lecture, 3 hours).
Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-363 Econometrics
Fall and Spring: 9 units
This course takes as its starting point ordinary-least-squares estimation and the linear regression model, which are presented utilizing vector and matrix notation. This is followed by the application of OLS to non-linear models. Cases are then considered where the various assumptions of OLS do not hold and what corrective actions should be taken. Topics include: nonlinear-least-squares, two-stage estimation, instrumental variables, simultaneous equations, maximum likelihood estimation, and logit/probit models. (Lecture, 3 hours; Recitation, 1 hour). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-122) and (21-256 or 21-259) and (73-100) and (73-230) and (36-225 or 36-217) and (36-226).

73-365 Firms, Market Structures, and Strategy
Fall: 9 units
This course is concerned with the economic analysis of industrial markets that are not perfectly competitive. The effects of imperfect competition on firms’ decisions (pricing, location, advertising, research and development, among others) are reviewed. Implications of these effects in terms of public policy are also discussed from a variety of perspectives. Finally, applications to actual markets are considered. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-371 International Trade and Economic Development
Intermittent: 9 units
This course examines the economic rationale for trade among nations and its consequences for global economic development. Topics include: comparative advantages among nations, the free trade versus protectionism debate, and the effects of special trade agreements, free trade zones, and transnational economic unions. (Lecture, 3 hours). Minimum grade standard applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240).

73-372 International Money and Finance
Spring: 9 units
The course concerns itself with the determination of real, monetary, and financial aggregates and the policies that influence them in an international context. Topics include: monetary policy and its effects on employment and inflation, the role of the banking system in the transmission of monetary policy, credit markets, banks as financial intermediaries, and the effect of domestic policies on international trade and financial markets. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-259 or 21-256) and (73-100) and (73-230) and (73-240).

73-375 History of Money and Monetary Policy
Spring: 9 units
This course will consider the evolution of monetary institutions and policies from 550 BC to the present, providing an understanding of the role of monetary policy through a critical evaluation of the mistakes and successes of the past. Specific topics will include: Greek, Roman, and Medieval coinage; metallic systems including strengths and weaknesses of the gold standard and bimetallism; American colonial experiences; French episodes including the “system” of John Law and the Assignats of the French Revolution; critical British episodes including the Great Debassement and the Restriction of 1797-1821; and the following topics in United States history: the Constitution, early problems, Greenbacks of the Civil War, legal tender cases, the “Crime of 1873,” founding of the Federal Reserve, Great Depression, Bretton Woods, and Inflation, the Volcker disinflation, and the financial crisis of 2008-10. The course will include a bit of general history and history of economic thought, with just enough economic theory to provide analytical coherence. (Lecture, 3 hours).
Prerequisite: 73-100.

73-390 Behavior in Games, Auctions, and Markets
Intermittent: 9 units
This course examines models describing economic/strategic behavior in environments where the usual “perfectly rational agents” paradigm does not capture observed phenomena. Topics include: decisions and the endowment effect, heuristics and biases in decision making, overconfidence and under-confidence effects, myopia and under-saving, public goods games, learning and reputation in repeated games, fairness and reciprocity in labor markets, asset markets and the bubble mystery, the winner’s curse in auctions, and optimal contract design. (Lab/Lecture, 3 hours).
Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-392 Financial Economics
Spring: 9 units
A rigorous quantitative course covering the economic fundamentals of financial markets. The course covers individual decision making about saving and investment under uncertainty, and the equilibrium determination of asset prices for both complete- and incomplete-market settings. In addition, the course will cover topics in corporate financial decision making and the micro-structure of financial markets. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-122) and (21-259 or 21-256) and (73-100) and (73-230) and (73-240).
73-394 Development Economics
Fall: 9 units
This course will explore issues relating to economic development in low and middle-income countries. We will discuss topics such as economic growth and inequality, education, health, the family, and the markets for land, labor, and credit. We will study how market failures can potentially prevent economic growth in the developing world. Also we explore the effectiveness of different types of policies in promoting development. The course will use both economic theory and empirical methods to answer these questions. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-395 Independent Study in Economics
Fall and Spring
The Independent Study course in economics allows the student to pursue his or her own research interests in any of a variety of topics in economics. A typical independent study course involves a semester long project under the supervision of an appropriate faculty advisor. The nature and scope of the project are determined by the student and faculty advisor. Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240).

73-399 Junior Honors Seminar
Spring: 6 units
The Juniors Honors Research Seminar is offered to students who are eligible to write a Senior Honors Thesis in Economics. The purpose of this course is to prepare students for the successful completion of an honors thesis. Topics will include: research methodology in Economics, the use of literature reviews, choosing a manageable research topic, the writing process, and more. Entrance into the course is by invitation only. Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240) and (73-407 or 73-363).

73-405 Introduction to Dynamic Economics
Intermittent: 9 units
This course will develop the basic ideas and tools for analysis of economies moving through an ongoing sequence of time periods, rather than analysis limited to non-operational constructs such as "short run" or "long run." In this case, one thinks of equilibria as processes, not specific values of variables. In dynamic analysis, expectations about future conditions are of great importance, as are costs of adjusting variables from one period to the next. Emphasis will be given to rational expectations, the prevailing hypothesis, but some attention will be devoted to learning. Applications will include both macro and microeconomic issues. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240) and (73-407 or 73-363).

73-407 Fundamentals of Statistical Modeling
Spring: 9 units
This course provides a one-semester introduction to the theory of probability and mathematical statistics. The course will emphasize probability models and distribution theory; the practice of statistical inference based on the use of maximum likelihood estimation; and applications of statistical modeling and inference, using case studies drawn from the social, physical and biomedical sciences. The use of a computer software package will be an integral part of this course. Students who have taken 36-225 or 36-625 may not receive credit for this course.
Prerequisites: (21-120) and (21-256 or 21-259) and (36-247 or 36-208 or 36-202 or 36-220 or 36-309 or 70-208).

73-408 Law and Economics
Spring: 9 units
This course will provide a broad overview of the scholarly field known as "law and economics." The focus will be on how legal rules and institutions can correct market failures. We will discuss the economic function of contracts and, when contracts fail or are not feasible, the role of legal remedies to resolve disputes. We will also discuss at some length the choice between encouraging private parties to initiate legal actions to correct externalities and governmental actors, such as regulatory authorities. Extensive attention will be given to the economics of litigation, and to how private incentives to bring lawsuits differ from the social value of litigation. The economic motive to commit crimes, and the optimal governmental response to crime, will be studied in depth. Specific topics within the preceding broad themes include: the Coase Theorem; the tradeoff between the certainty and severity of punishment; the choice between ex ante and ex post sanctions; negligence versus strict liability; property rules; remedies for breach of contract; and the American rule versus the English rule for allocating litigation costs. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-410 The Economics of Business Cycles
Intermittent: 9 units
The purpose of this course is to educate the student in modern business cycle theory. The first part of the course surveys the empirical regularities, which comprise fluctuations in aggregate economic activity, which economists have labeled business cycles. The second part of the course discusses the existing macroeconomic models, which students have learned in intermediate macroeconomics, while the third part of the course examines the policy implications of these models and the inadequacies of the models as economic explanations of cycles. The final part of the course discusses rational expectations models of the business cycle in considerable detail. The empirical implications of these new models are examined, and their policy implications are assessed. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-407 or 73-363).

73-420 Monetary Theory and Policy
Intermittent: 9 units
This course is concerned with various topics in monetary and macroeconomics including anticipated inflation, hyperinflation, output effects of monetary policies, alternative techniques of monetary policy implementation, and the interaction of monetary and fiscal policy strategies. Analysis of these issues is conducted by means of simple by explicit dynamic models incorporating rational expectations. In addition, attention is devoted to alternative types of monetary systems – commodity vs. paper money, for example. This segment of the course includes some consideration of issues relating to a technologically advanced society in which transactions are carried out by means of a computerized economy-wide bookkeeping system, rather than by money. (Lecture, 3 hours). Minimum grade standard of "C" applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-407 or 73-363).
73-421 Emerging Markets
Fall: 9 units
Course Description: The aim of the course is to understand the economic, political and institutional forces that spur or hinder business activity and success in developing countries. The course is designed to provide an overview of fiscal, monetary, trade and labor market policies adopted in emerging economies, and how these policies have impacted and continue to impact small and large businesses, investment opportunities and the growth potential of these countries. The course will focus on successful emerging economies such as India, China, Turkey, Brazil, with broader lessons and comparisons drawn from developed countries, as well as from failures in other developing nations. The broad set of questions we will address in the class are the following: – Policy and business in developed countries: – How does fiscal policy impact large and small business? How does it differ across OECD countries? – How do credit policies and frictions impact the creation, growth and death of firms? Lessons from the recent financial crisis. – How does labor market policy (hiring and firing laws, contracts, mandated benefits) impact business and the labor markets? – How do copyrights and patent spur innovation? – Policy and business in developing countries: – How does fiscal policy, labor market regulations, property rights vary around the world? Why do they matter? – How does government corruption, rents and bureaucracy hinder development: the case of Peru; – How does poverty hinder entrepreneurship? What are effective policies to alleviate this problem: the case of India and Thailnd; – How do trade policy impact businesses in developing countries: the case of NAFTA and Mexico. – How do exchange rate controls/movements affect businesses and overall trade in emerging economies?
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240).

73-422 Real Estate Economics and Finance
Intermittent: 9 units
The principle objective of this course is to analyze the financial characteristics of real assets and their derivative products, as well as to provide an introduction to their associated institutions. Topics include: residential real estate markets, urban land markets, analysis of mortgages and mortgage markets, commercial property markets, financial valuation of real assets, influence of debt financing on risk and returns, innovations in real estate capital markets, and analysis of asset allocation decisions. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-426 Advanced Quantitative Economic Analysis
Intermittent: 9 units
This course builds on the concepts developed in 36-226 and 73-261 and provides an introduction to advanced economic analysis at the undergraduate level. The main objectives of the course are: to provide a solid core of analytical and conceptual tools that students can use directly in their research; to give students an understanding of both the classic theory and some of the recent advances; to enable students to perform analysis by structuring the problem as a formal model and performing analysis of which outcomes are placed on negotiation exercises, role playing, and on student discussion and negotiations within and between organizations. Considerable emphasis will be placed on negotiation exercises, role playing, and on student discussion and analysis of actual current and past negotiation situations. (Lab/Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (36-401 or 73-363).

73-428 Markets for Energy
Intermittent: 9 units
This course offers students a broad survey of the oil, natural gas, and electric-power industries, with a particular focus on their transformation from vertically-integrated, regulated entities to organizations participating in open markets and on the role of new technologies which enabled these changes. Topics include: economics of resource extraction, volatility in futures markets for oil and natural gas, the rise and fall of OPEC, power systems engineering and economics, and wholesale markets for electric power. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-432 Economics of Education
Intermittent: 9 units
In this course we examine economic issues related to education, particularly at the elementary and secondary level. In exploring why we care about education, we examine the private returns to education (those that accrue to the individual) and the social returns (those that accrue to society), and how social returns provide one rationalization for government’s involvement in education. After an overview of basic facts related to the provision of elementary and secondary education in the United States, we turn to the issue of how education is produced. We study the role of financial resources, teachers and peers in the production process, and examine evidence on the effectiveness of public vs. private schools. In the face of evidence that public schools in the United States do not fare well in international comparisons, one response has been to give parents greater choice of schools for their children. This leads us to study the most prevalent school choice mechanism (choosing where to live), as well as charter schools and private school vouchers. Another response has been the movement to hold public schools accountable, of which the No Child Left Behind legislation is an example. Thus, we examine issues on accountability theory and practice. The concern remains, however, that even if elementary and secondary education were significantly improved through various mechanisms, the cognitive ability of some children would already lag behind by the time they start school due to their early childhood experiences. In this spirit we analyze evidence on early childhood interventions for disadvantaged children. Building on our understanding of educational outcomes through high school, we finalize with an overview of the market for higher education, with an emphasis on college pricing and admission decisions. Throughout we use microeconomic analysis tools, and we examine empirical evidence that applies econometric techniques.
Prerequisites: 73-150 and 73-226.

73-435 Economics of Negotiations
Intermittent: 9 units
The objective of this course is to understand the influence of economic factors upon both the conduct of involved parties and upon their anticipated outcomes. Insights gained from economic analysis are used to help find profitable negotiation strategies and to help evaluate opportunities which depend upon a negotiated outcome. Topics include: the creation and allocation of economic value; the negotiator’s fundamental decision problem; the tension between creating and claiming value; strategies for better agreements; the role of coalitions in multi-party negotiations; negotiations within and between organizations. Considerable emphasis will be placed on negotiation exercises, role playing, and on student discussion and analysis of actual current and past negotiation situations. (Lab/Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-440 Auctions and Markets
Spring: 9 units
Fall or Spring This course investigates auctions and markets. Part analytical, part experimental, and partly data driven, it shows how the outcomes of different auction and trading mechanisms depend on the characteristics of the bidders and traders, the bidding or trading rules, and the information that the traders have. The course makes extensive use of Comlabgames to simulate the various types of auctions and markets we analyze. It is divided into four roughly equal parts. Part 1 is an introduction to limit order markets, and a detailed study of auctions, arguably the simplest market form. Part 2 extends our analysis of auction to monopoly, which differs from the simplest auctions because multiple units are sold and the monopolist can restrict sales. In he third part we investigate the effects of adding sellers and buyers to both sides of the market. Finally we extend our analysis to multi-market settings, such as stock exchanges, and use the concept of competitive equilibrium to predict behavior in limit order markets. (Lab/Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-450 Economics Colloquium
1 unit
Economics majors meet for one hour each week to hear discussions on current research by faculty or students, presentations on economics from economists outside academia, and expository talks on selected economics topics not part of the usual curricula. Also will include topics of special interest to undergraduates such as preparation for graduate school and topics in the press.
73-458 Money, Banking and Financial Markets  
Intermittent: 9 units  
Fall or Spring  
This course will help the student to understand the interaction of real, monetary, and financial macroeconomic variables and the policies that influence them. In the first half of the course, we study the joint determination of aggregate output and the real interest rate in a modern model of monetary policy. We see how interest rate policy offsets fluctuations in employment and inflation that otherwise would arise due to macroeconomic shocks. And we see why inflation targeting is welfare-maximizing monetary policy. We describe how the Federal Reserve thinks about interest rate policy in practice with reference to the policy record from the late 1970s to the present covering: the “inflation scare” problem, the Volcker disinflation, the Greenspan era, and the case for inflation targeting in the US. The second half of the course shifts the focus to money, credit, and banking. We address money as the medium of exchange, credit in the exchange process, and the role of banks in the payments system. We study the role that the banking system plays in money stock determination and in the transmission of monetary policy. We then cover the motivation for borrowing and lending in credit markets, the two-country model of international finance, the cost of external finance, and the role of banks as financial intermediaries. We discuss banking and financial market distress with reference to recent events. Finally, we distinguish between banking and monetary policies, and assess the power of such policies, including “last resort lending,” to act against financial fragility. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-150) and (73-200).

73-465 Technology Strategy  
Spring: 9 units  
This course is about business strategy for technology-intensive industries. Examples of such industries are computer hardware and software, media and entertainment, telecommunications and e-commerce. We will explore the unique economic circumstances facing firms in these industries and identify strategies that enable firms to succeed given these circumstances. You will learn to analyze pricing strategies including versioning and bundling; product standardization decisions; managing product complements; exploiting network effects; managing platform competition. This course will help you understand the unique economic characteristics seen in today’s technology-intensive markets and how they impact the strategic interactions among firms and consumers. We will study, for example: Why firms in the IT industry give away their best products for free. Why makers of video gaming consoles subsidize end users (but tax game developers) while computer operating system makers subsidize software developers (but overcharge end users). Why Sony won the Blu-Ray format war against HD-DVD which was sponsored by a whole new industry of Blu-Ray content providers. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-150) and (73-200).

73-469 Global Electronic Markets: Economics and the Internet  
Fall: 9 units  
The information revolution brought about by the Internet is having a dramatic impact on economic activity. Long-term contractual relationships that once governed corporate procurement are being dismantled as manufacturers use the Internet to market directly to the public. New transportation networks that used to simply move goods from point A to point B are evolving into dynamic inventory pipelines that allow manufacturers to track and even reroute shipments in real time. At the same time, individuals are making use of sophisticated search engines to comparison shop at a scale that would have been physically exhausting even five years ago. In the Economics of E-commerce, we will use the basic tools of economic analysis to understand how and why the changes in information technology are reshaping the economic landscape. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property  
Spring: 9 units  
Healthy economies in many ways resemble healthy people — they are alive and vibrant, growing and adjusting in response to changing circumstances — and what fuels economic growth and innovation are ideas. This course explores the role of ideas in the modern economy. Topics include: models of economic growth, economic efficiency and development, innovation and human capital, intellectual property and public policy issues. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230).

73-476 American Economic History  
Intermittent: 9 units  
The study of economic history provides important perspective on current economic institutions and policies. A failure to understand the historical evolution of economic institutions or the variety of past economic experience is perhaps the worst shortcoming of many economists. The study of economic history provides an opportunity to test currently fashionable theories against data different from those used in their construction. In fact, this is a course in applied economics. The theories developed in the intermediate courses will be applied to episodes from the past in ways that increase understanding both of the specific historical episodes considered and the economic theories employed. (Lecture, 3 hours). Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (73-100) and (73-230) and (73-240) and (36-208 or 70-208 or 36-202 or 36-220).

73-495 Advanced Independent Study in Economics  
All Semesters  
The Independent Study course in economics allows the student to pursue his or her own research interests in any of a variety of topics in economics. A typical independent study course involves a semester long project under the supervision of an appropriate faculty advisor. The nature and scope of the project are determined by the student and faculty advisor. Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-256 or 21-259) and (21-122) and (73-100) and (73-230) and (73-240) and (73-252).

73-497 Senior Project  
Fall: 9 units  
A four-year project course, open only to Economics primary and additional majors with Senior standing. Minimum grade standard of “C” applies only to economics courses.  
Prerequisites: (21-120) and (21-259 or 21-256) and (73-100) and (73-230) and (73-240) and (73-407 or 36-226).

73-500 Tepper College Honors Thesis I  
Fall and Spring  
Economics majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and approved by faculty. Prerequisites: Senior standing in the Economics Program and permission of the Economics faculty.

73-501 Tepper College Honors Thesis II  
Fall and Spring  
Economics majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and approved by faculty. Prerequisites: Senior standing in the Economics Program and permission of the Economics faculty.

Electrical Computer Engineering Courses

18-100 Introduction to Electrical and Computer Engineering  
Fall and Spring: 12 units  
The goals of this freshman engineering course are: * To introduce basic concepts in electrical and computer engineering in an integrated manner; * To motivate basic concepts in the context of real applications; * To illustrate a logical way of thinking about problems and their solutions, and; * To convey the excitement of the profession. These goals are attained through analysis, construction and testing of an electromechanical system (e.g., a robot) that incorporates concepts from a broad range of areas within Electrical and Computer Engineering. Some of the specific topics that will be covered include: system decomposition, ideal and real sources, Kirchhoff’s Current and Voltage Laws, Ohm’s Law, piecewise linear modeling of nonlinear circuit elements, Ideal Op-Amp characteristics, combinational logic circuits, Karnaugh Maps, Flip-Flops, sequential logic circuits, and finite state machines. 3 hrs. lec., 1 hr. rec., 3 hr. lab.  
Corequisite: 21-120.
18-200 Emerging Trends in Electrical and Computer Engineering
Fall: 1 unit
This class consists of a series of individual lectures given by different faculty members and distinguished alumni. The lectures are designed to serve the following purposes: 1) provide students a good understanding of our curriculum structure and the courses in each of our five principle subject areas; 2) introduce students to emerging trends in electrical and computer engineering and the relevance of our courses; 3) present to students our faculty's research fields; 4) discuss basic learning and working ethics; 5) prepare students career-making skills; 6) introduce new undergraduate courses and research opportunities. The class will contain 12 lectures from faculty members, 2 lectures on learning and working ethics, and 2 lectures from our alumni. Students are required to attend each lecture. An award for the best lecturer, selected by students, will be given at the end of the semester. 1 credit, 1 hr per week, pass/fail, required to graduate. Sophomore standing required. Prerequisite: 18-100.

18-202 Mathematical Foundations of Electrical Engineering
Fall and Spring: 12 units
This course covers topics from engineering mathematics that serve as foundations for descriptions of electrical engineering devices and systems. It is the corequisite mathematics course for 18-220, Fundamentals of Electrical Engineering. The topics include: (1) MATLAB as a robust computational tool, used to reinforce, enrich and integrate ideas throughout the course, including software exercises and projects in combination with homework assignments, (2) Complex Analysis, including rectangular and polar representations in the complex plane with associated forms of complex arithmetic, powers, roots and complex logarithms, complex differentiation, analytic functions and Cauchy-Riemann equations, complex Taylor series, complex exponential, sinusoidal and hyperbolic functions, and Euler's formula, (3) Fourier Analysis, including orthogonality of sinusoids, trigonometric and exponential forms of Fourier series, Fourier integrals and Fourier transforms, (4) Linear, Constant-Coefficient Differential Equations, including complex exponential solutions to homogeneous equations and particular solutions with polynomial and sinusoidal driving functions described by phasors, (5) Difference Equations, with emphasis upon their relationship to differential equations, and (6) Linear Algebra and Matrices, including matrix arithmetic, linear systems of equations and Gaussian elimination, vector spaces and rank of matrices, matrix inverses and determinants, eigenvalue problems and their relationship to systems of homogeneous differential equations. 4 hrs. lec., 1hr. rec. Prerequisites: 21-122 or 21-118 or 21-123.

18-213 Introduction to Computer Systems
Spring and Summer: 12 units
This course provides a programmer's view of how computer systems execute programs, store information, and communicate. It enables students to become more effective programmers, especially in dealing with issues of performance, portability and robustness. It also serves as a foundation for courses on compilers, networks, operating systems, and computer architecture, wherein a deeper understanding of systems-level issues is required. Topics covered include: machine-level code and its generation by optimizing compilers, performance evaluation and optimization, computer arithmetic, memory organization and management, networking technology and protocols, and supporting concurrent and distributed systems. Students must achieve a C or better in order to use this course to satisfy the prerequisite for any subsequent Computer Science course. Prerequisites: 15-123 (Grade of C or higher is required in the prerequisite) Prerequisite: 15-122.

18-220 Electronic Devices and Analog Circuits
Fall and Spring: 12 units
This course covers fundamental topics that are common to a wide variety of electrical engineering devices and systems. The topics include an introduction to semiconductor devices and technology, DC circuit analysis techniques, operational amplifiers, energy storage elements, sinusoidal steady-state response, frequency domain analysis, filters, and transient response of first- and second-order systems. The laboratories allow students to use modern electronic instrumentation and to build and operate circuits that address specific concepts covered in the lectures, including semiconductor devices and sensors, laser diode, photodetectors, signal detection and processing, power converters and circuit transients. 3 hrs. lec., 1 hr. rec., 3 hrs. lab. Prerequisite: 18-100 Corequisites: 33-107, 18-202.

18-231 Sophomore Projects
Fall
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-232 Sophomore Projects
Spring
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student’s schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-240 Structure and Design of Digital Systems
Fall and Spring: 12 units
This course introduces basic issues in design and verification of modern digital systems. Topics include: Boolean algebra, digital number systems and computer arithmetic, combinational logic design and simplification, sequential logic design and optimization, register-transfer design of digital systems, basic processor organization and instruction set issues, assembly language programming and debugging, and a hardware description language. Emphasis is on the fundamentals: the levels of abstraction and hardware description language methods that allow designers to cope with hugely complex systems, and connections to practical hardware implementation problems. Students will use computer-aided design software and actual hardware implementation laboratories to learn about real digital systems. 3 hr. lec., 1 hr. rec., 3 hr. lab. Prerequisite: 18-100 Corequisite: 21-127.

18-290 Signals and Systems
Fall and Spring: 12 units
This course develops the mathematical foundation and computational tools for processing continuous-time and discrete-time signals in both time and frequency domain. Key concepts and tools introduced and discussed in this class include linear time-invariant systems, impulse response, frequency response, convolution, filtering, sampling, and Fourier transform. Efficient algorithms like the fast Fourier transform (FFT) will be covered. The course provides background to a wide range of applications including speech, image, and multimedia processing, bio and medical imaging, sensor networks, communication systems, and control systems, This course serves as entry and prerequisite for any higher level course in the fields of signal processing, communications, and control. Prerequisites: 18-100 Corequisites: 18-202 Prerequisite: 18-100 Corequisite: 18-202.
18-300 Fundamentals of Electromagnetics
Fall: 12 units
This course introduces electromagnetic principles and describes ways in which those principles are applied in engineering devices and systems. Topics include: vector calculus as a mathematical foundation for field descriptions, Maxwell’s equations in integral and differential forms with associated boundary conditions as descriptions of all electromagnetic principles, quasi-static electric fields in free space and in materials, superposition for known charge sources, conduction and polarization, resistance and capacitance, charge relaxation, analytic and numerical methods for electric field boundary value problems, quasi-static magnetic fields in free space and in materials, superposition for known current sources, magnetization, inductance, magnetic diffusion, and analytic and numerical methods for magnetic field boundary value problems. 4 hrs. lec. Prerequisite: 18-220.

18-310 Fundamentals of Semiconductor Devices
Spring: 12 units
This course replaced 18311 in Spring 2005. In this course you will receive an introduction to the operation and fabrication of the most important semiconductor devices used in integrated circuit technology together with device design and layout. At the end of the course you will have a basic understanding of pn diodes, bipolar transistors, and MOSFETs as well as some light emitting and light detecting devices such as photodiodes, LEDs and solar cells. You will also receive an introduction to the fundamental concepts of semiconductor physics such as doping, electron and hole transport, and band diagrams. In the laboratory you will learn how to lay out both bipolar and MOS devices and you will design small (2-3 transistor) circuits. The laboratory portion of the course emphasizes the relation between device design and layout and circuit performance. You will also experimentally evaluate the operation of amplifier and gate circuits fabricated with discrete devices. This course will give you an excellent understanding of the operation and fabrication of the devices which is necessary for high-performance analog and digital circuit design. 3 hrs. lec. (Note: the prerequisite is typically waived for MSE students who intend to pursue the Electronic Materials Minor.) Prerequisite: 18-220.

18-320 Microelectronic Circuits
12 units
Prerequisite: 18-220 Corequisite: 18-240.

18-331 Junior Projects
Fall
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member conducting the research with, the ECE Undergraduate Office will add the course to the student’s schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-332 Junior Projects
Spring
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member conducting the research with, the ECE Undergraduate Office will add the course to the student’s schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-340 Digital Computation
Spring: 12 units
In this course we will explore the techniques for designing high-performance digital circuits for computation along with methods for evaluating their properties. We begin by quickly reviewing number systems and digital arithmetic along with basic arithmetic circuits such as ripple-carry adders. We then focus on formal techniques and theory for analyzing the functionality, timing, power consumption, and chip area properties of these basic circuits and ones yet to be presented. From there, we move to more complex adders (carry-lookahead, carry-skip, carry_bypass, Wallace trees, and hybrid techniques) and multipliers (sequential, array, Booth, and others) along with various divider circuits. Floating point units are then built upon the concepts introduced for adder, multipliers, and dividers. Finally, we will investigate the design and implementation of digital filter circuits. For each circuit introduced, we will develop techniques for evaluating their functionality, their speed, power consumption, and silicon area requirements. In addition, we will utilize various CAD tools to design and evaluate most of the computation circuits discussed. After successful completion of the course, students will not only have an understanding of complex computation circuits, but subtle concepts that include hazards, metastability, false paths, inertial delay, sticky bits, clock skew/jitter, dynamic and static sensitization, and many others. 3 hrs. lec., 1 hr. rec. Prerequisite: 18-240.

18-341 Logic Design Using Simulation, Synthesis, and Verification Techniques
Spring: 12 units
This course is a second level logic design course, studying the techniques of designing at the register-transfer and logic levels of complex digital systems using modern simulation, synthesis, and verification tools. Topics will include register-transfer level systems (i.e., finite state machines and datapaths), bus and communication system interfacing (such as a simplified USB), asynchronous state machines, discrete-event simulation, debugging and testbench strategies, and assertion-based verification. Design examples will be drawn from bus and communication interfaces, and computation systems, emphasizing how these systems are designed and debugged, and how their functionality can be verified. A modern hardware description language, SystemVerilog, will serve as the basis for unifying these topics. Quizzes, homeworks and design projects will serve to exercise these topics. 3 hrs. lec., 1 hr. rec. Prerequisite: 18-240. Prerequisite: 18-240.

18-342 Fundamentals of Embedded Systems
12 units
Prerequisite: 18-240.

This practical, hands-on course introduces students to the basic building blocks and the underlying scientific principles of embedded systems. The course covers both the hardware and software aspects of embedded processor architectures, along with operating system fundamentals, such as virtual memory, concurrency, task scheduling and synchronization. Through a series of laboratory projects involving state-of-the-art processors, students will learn to understand implementation details and to write assembly-language and C programs that implement core embedded OS functionality, and that control/debug features such as timers, interrupts, serial communications, flash memory, device drivers and other components used in typical embedded applications. Relevant topics, such as optimization, profiling, digital signal processing, feedback control, real-time operating systems and embedded middleware, will also be discussed. This course is intended for INI students. Anti-requisites: 18348 or 18349 Prerequisite: 18-240.

18-345 Introduction to Telecommunication Networks
Spring: 12 units
This course introduces the fundamental concepts of telecommunication networks. Underlying engineering principles of telephone networks, computer networks and integrated digital networks are discussed. Topics in the course include: telephone and data networks overview; OSI layers; data link protocol; flow control, congestion control, routing; local area networks (Ethernet, Token Ring and FDDI); transport layer; introduction to high-speed networks; performance evaluation techniques. 4 hrs. lec. Prerequisites: 18-240 and 36-217 and 15-122.
18-348  Embedded Systems Engineering  
Spring: 12 units  
Embedded computing applications far outnumber desktop computers, with billions of microcontrollers produced worldwide each year. Embedded systems vary tremendously, from the single 8-bit processor in a thermostat, to high performance processors in a digital camera, to dozens of networked processors in an automobile. Despite this diversity of applications, there are core technology and system-level skills needed by any embedded system designer that form the content of this course. The emphasis of this course will be at the system layer where hardware meets software, with plenty of hands-on experience at "bare metal" programming. Topics typically covered include embedded computing platforms (hardware, microcontroller instruction sets, software in both assembly language and C); interacting with the external world (analog I/O, digital I/O, serial ports, filtering, control, embedded networks); system-level engineering (design cycle, architectural patterns, peer reviews); real-time operation (timers, interrupts, concurrence, task switching, writing a simple RTOS kernel, scheduling); constraints and optimization (economics, power, performance); and a survey of techniques important for building systems that work in the real world (debug, test, robust design, dependability, safety, ethical/societal issues). Weekly hands-on hardware and software experiences with a 16-bit microcontroller module will tie directly to lectures to reinforce core skills. 4 hrs. lec., 1 hr. rec., 3 hrs. lab. Anti-requisites: 18342 or 18349  
Prerequisites: 18-240 and 18-213.

18-349  Embedded Real-Time Systems  
Fall: 12 units  
This practical, hands-on course introduces the various building blocks and underlying scientific and engineering principles behind embedded real-time systems. The course covers the integrated hardware and software aspects of embedded processor architectures, along with advanced topics such as real-time resource management. Students can expect to learn how to program with the embedded architecture that is ubiquitous in cell-phones, portable gaming devices, robots, PDAs, etc. Students will then go on to learn and apply real-time principles that are used to drive critical embedded systems like automobiles, avionics, medical equipment, the Mars rover, etc. Topics covered include embedded architectures (building up to modern 16/32/64-bit embedded processors); interaction with devices (buses, memory architectures, memory management, device drivers); concurrency (software and hardware interrupts, timers); real-time principles (multi-tasking, scheduling, synchronization); implementation trade-offs, profiling and code optimization (for performance and memory); embedded software (exception handling, loading, mode-switching, programming embedded systems). Through a series of laboratory exercises with state-of-the-art embedded processors and industry-strength development tools, students will acquire skills in the design/implementation/debugging of core embedded real-time functionality. Anti-requisites: 18342 or 18348  
Prerequisites: 18-240 and 18-213.

18-370  Fundamentals of Control  
Fall: 12 units  
An introduction to the fundamental principles and methodologies of classical feedback control and its applications. Emphasis is on problem formulation and the analysis and synthesis of servomechanisms using frequency and time-domain techniques. Topics include analytical, graphical, and computer-aided (MATLAB) techniques for analyzing and designing automatic control systems; analysis of performance, stability criteria, realizability, and speed of response; compensation methods in the frequency domain, root-locus and frequency response design, and pole-zero synthesis techniques; robust controller design; systems with delay and computer control systems; transfer function and state space modeling of linear dynamic physical systems; nonlinearities in control systems; and control engineering software (MATLAB). 4 hrs. lec., 1 hr. rec.  
Prerequisites: 18-290 or 18-396.

18-390  ECE CO-OP  
Fall and Spring  
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is cooperative education, which provides a student with an extended period of exposure with a company. To participate, students must complete an ECE Co-op Approval form (located in HH 1115) and submit for approval. Students must possess at least junior status and have an overall grade point average of 3.0 or above. All co-ops must be approved by the 18-390 office in underclassmen. If the co-op is approved, the ECE Undergraduate Studies Office will add the course to the student's schedule. Upon completion of the co-op experience, students must submit a 1-2 page report of their work experience, and a 1-2 page evaluation from the company supervisor to the ECE Undergraduate Studies Office. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE’s website.

18-391  Noisy Signal Representation and Processing  
Spring: 12 units  
Please refer to the ECE webpage for a full description of this course. http://www.ece.cmu.edu/courses/18391  
Prerequisites: 18-202 and 36-217 and (18-290 or 18-396).

18-401  Electromechanics  
12 units  
This course provides a broadly based introduction to interactions between mechanical media and electromagnetic fields. Attention is focused on the electromechanical dynamics of lumped-parameter systems, wherein electrical and mechanical subsystems may be modeled in terms of discrete elements. Interactions of quasi-static electric and magnetic fields with moving media are described and exemplified. Unifying examples are drawn from a wide range of technological applications, including energy conversion in synchronous, induction, and commutator rotating machines, electromechanical relays, a capacitor microphone and speaker, and a feedback-controlled magnetic levitation system. 4.5 hrs. rec.  
Prerequisite: 18-300.

18-402  Applied Electrodynamics  
Spring: 12 units  
This course builds upon the electric and magnetic field foundations established in 18-300 to describe phenomena and devices where electromagnetic waves are a central issue. Topics include: review of Maxwell’s equations, propagation of uniform plane waves in lossless and lossy media, energy conservation as described by the Poynting Theorem, reflection and transmission with normal and oblique incidence upon boundaries, sinusoidal steady state and transients on 2-conductor transmission lines, modal descriptions of waveguides, radiation and antennas. 4 hrs. lec.  
Prerequisite: 18-300.

18-410  Physical Sensors, Transducers and Instrumentation  
Spring: 12 units  
While modern electronic circuits have become largely digital, the physical world, and consequently, the electronic interface to the physical world remains fundamentally analog. Therefore, sensors, transducers, and the initial signal processing remain in the analog domain. Simultaneously, the commercial market place optimizes sensor technology based upon multiple attributes including cost, detectivity, size, speed, etc. In this course we explore both the many types of possible responses to various physical stimuli, as well as the instrumentation, electronic detection, signal conversion and signal processing techniques used to bring the physical event into the electronic world in a practical manner. This requires that we learn about the diversity of physical phenomena, materials and devices that can be used to convert the various forms of physical energy into electronic signals. Due to the significant diversity of physical phenomena the course requires reading from textbooks, the technical literature and patent literature. The course is taught via the case method with student participation via oral and written reports. The student should arrive with a strong interest in, and basic understanding of, physics, material science, chemistry and analog electronic circuits as taught at the sophomore and junior course level.  
Prerequisites: 18-300 or 18-303 or 18-310 or 18-311 or 18-321 or 27-432.

18-411  Computational Techniques in Engineering  
Spring: 12 units  
This course develops the methods to formulate basic engineering problems in a way that makes them amenable to computational/numerical analysis. The course will consist of three main modules: basic programming skills, discretization of ordinary and partial differential equations, and numerical methods. These modules are followed by two modules taken from a larger list: Monte Carlo-based methods, molecular dynamics methods, image analysis methods, and so on. Students will learn how to work with numerical libraries and how to compile and execute scientific code written in Fortran-90 and C++. Students will be required to work on a course project in which aspects from at least two course modules must be integrated.  
Prerequisites: 15-110 and 21-120 and 21-122 and 21-259 and 21-260.
18-415 From Design to the Market for Deep Submicron IC’s
Spring: 12 units
The general objective of the 18-415 class is to introduce and analyze all major design-dependent trade-offs which decide about the IC product commercial success. This objective will be achieved via playing in the class an “imaginary fableless IC design house startup game”- a main class activity. In this game students will be asked to construct “business plans” for a startup fabless IC design house. Each team in the class will have to envision, as an IC design objective, a new product with a functionality, which is already provided by another existing IC product (i.e. by microprocessor). The envisioned product should provide a subset of functionality of the existing product but it should be “better” in some other respect (e.g. it could be less expensive to fabricate, faster etc.). To handle the above assignment, students in the class will be using skills learned in 18-322 as well as all legal sources of “industrial intelligence” typically available for the IC industry. They can also use the class teacher as a source of free consulting, as well as, they can ask for any sequence of lectures or literature sources which they will need to meet the class objectives.
Prerequisite: 18-320.

18-418 Electric Energy Processing: Fundamentals and Applications
Fall: 12 units
This course provides an introduction to the fundamentals of electric energy conversion, and its use in several real-life electric energy systems. The course starts with a brief review of electromagnetic and electromechanical conversion underlying electric power generation. The first part of the course introduces basic concepts found in today’s electric energy systems, such as 1) electric machines (generators and motors), 2) power electronics for converting between AC and DC portion of an electric energy system, and 3) control of these components for their efficient use. The principles underlying design, operations and control of these components are introduced using conversion fundamentals and basic electric circuit knowledge. The second part of this course introduces several key electric energy systems used in today’s industry. Examples of such systems are 1) home distribution electric power systems; 2) electric power systems for vehicles; 3) electric power systems for ships; and 4) airspace electric power systems (such as airplanes and space shuttles). This course provides an important bridge between the applied physics and the systems areas in the ECE. It is intended to bring out the fact that it is electric energy and its conversion that underlies much of what one does in ECE.
Prerequisite: 18-220.

18-419 Semiconductor Device Applications - Optoelectronics and Nanoelectronics
Fall: 12 units
This course is designed to introduce important semiconductor optoelectronic devices and applications, such as light emitting diode (LED), solid state laser, photo-detector, solar cell, etc. All these devices and applications require a fundamental knowledge in optoelectronics as well as critical device design engineering. Developed on top of the fundamental knowledge covered in 18-310, the course begins with discussion on basic optics and device physics, it then focuses on operational principle, design engineering, and important applications of the devices. Special topics on novel nanoscale electronics and optoelectronics including nanowire, nano-particle light emitting and photovoltaic devices will also be discussed. In addition, an introduction to low-cost, flexible organic devices, e.g. display and solar cells will be presented. Prerequisite(s): 18-310
Prerequisite: 18-310.

18-431 Undergraduate Projects - Senior
Fall
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student’s schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-432 Senior Projects
Spring
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student’s schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-447 Introduction to Computer Architecture
Spring: 12 units
Computer architecture is the science and art of selecting and interconnecting hardware components to create a computer that meets functional, performance and cost goals. This course introduces the basic hardware structure of a modern programmable computer including, the basic laws underlying performance evaluation. We will learn, for example, how to design the control and data path hardware for a MIPS-like processor, how to make machine instructions execute simultaneously through pipelining and simple superscalar execution, and how to design fast memory and storage systems. The principles presented in lecture are reinforced in the laboratory through design and simulation of a register transfer (RT) implementation of a MIPS-like pipelined superscalar in Verilog.
Learning to design programmable systems requires that you already have the knowledge of building RT systems as is taught in the prerequisite 18-240, the knowledge of the behavior storage hierarchies (e.g., cache memories) and virtual memory as is taught in the prerequisite 15-213, and the knowledge of assembly language programming as is taught in the prerequisites. 3 hrs. lec., 3 hrs. lab.
Prerequisites: (18-240) and (15-213 or 18-213 or 18-243) and (18-340 or 18-341 or 18-348 or 18-349 or 18-320).

18-450 Digital Communications
Fall: 12 units
In this course, the communication problem will be introduced, and channel impairments such as noise, inter-symbol interference and fading will be described. Solutions to combat these impairments, based on digital communication theory, will be described. These will include signal space analysis, detection, equalization, coding and diversity. Throughout the course, the emphasis will be on discovering unifying ideas in transmission, rather than specifying the details of each application. 4 hrs. lec. This course was previously titled “Digital Wireless Communications”
Prerequisite: 18-391.

18-472 Fundamentals of Electric Power Systems
12 units
Prerequisites: 18-202 and 33-107.

18-474 Embedded Control Systems
Spring: 12 units
This course introduces principles for design of embedded controllers. In applications ranging from airplanes, to automobiles, to manufacturing systems, embedded computers now close feedback loops that were previously closed by mechanical devices or by humans in the loop. This course emphasizes practical insight into the tools for modeling and simulating these dynamic physical systems, and methods for designing the real-time software for embedded computers to control them. Lectures cover control system theory and background from real-time systems and control engineering, including event-based and clock-based sampling, switching control, PWM (pulse-width modulation), PID (proportional-integral-derivative) design, state-variable feedback, state estimation, and methods for setpoint control and trajectory tracking. Basic embedded computing, sensor, and actuator technologies are reviewed, including microcontrollers, DC motors and optical encoders. In the laboratory, students use commercial tools for simulation and automatic code generation to design and implement embedded control system experiments. 3 hrs. lecture, 3 hrs. lab.
Prerequisites: (15-213 or 18-243) and (18-396 or 18-370).
18-482 Telecommunications, Technology Policy & Management  
Spring: 12 units  
This course provides a comprehensive introduction to basic principles of telecommunications technology and the telephone network, and the legal, economic, and regulatory environment of the telecommunications industry. Role of new technologies such as fiber, integrated digital networks, computer communications, and information services. Common carrier law and the economics of natural monopoly as the basis for regulation of the telecommunications industry. Issues of competition, monopoly and technical standards. Spectrum allocation and management. International communications and transborder data flow. Special emphasis on how the new technologies have altered and are altered by regulation. Junior or Senior standing required.  
Prerequisite: 73-100.

18-487 Introduction to Computer & Network Security & Applied Cryptography  
Fall: 12 units  
Security is becoming one of the core requirements in the design of critical systems. This course will introduce students to the intro-level fundamental knowledge of computer security and applied cryptography. Students will learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, and applied cryptography. Students will also learn the fundamental methodology for how to design and analyze security critical systems.  
Prerequisites: 18-213 and 15-214.

18-491 Fundamentals of Signal Processing  
Fall: 12 units  
This course addresses the mathematics, implementation, design and application of the digital signal processing algorithms widely used in areas such as multimedia telecommunications and speech and image processing. Topics include discrete-time signals and systems, discrete-time Fourier transforms and Z-transforms, discrete Fourier transforms and fast Fourier transforms, digital filter design and implementation, and multi-rate signal processing. The course will include introductory discussions of 2-dimensional signal processing, linear prediction, adaptive filtering, and selected application areas. Classroom lectures are supplemented with implementation exercises using MATLAB.  
Prerequisite: 18-391.

18-493 Electroacoustics  
Fall: 12 units  
This course provides an introduction to physical, engineering, and architectural acoustics. The course begins with a review of the wave equation and some of its solutions that are relevant to the propagation of sound from planar and spherical sources, and from arrays of simple sources. Lumped parameter electrical circuit analogies are developed to describe mechanical and acoustical systems, leading to a discussion of the constraints and tradeoffs involved in the design of loudspeakers, microphones, and other transducers. The characteristics of sound in regular and irregular enclosures will be developed and discussed in the context of the acoustical design for rooms and auditoriums. The interaction of sound and man is also discussed, with introductory lectures on auditory perception and the acoustics of speech production, with applications in the areas of efficient perceptually-based coding of music and speech, and virtual acoustical environments.  
Prerequisites: 18-220 and 18-290.

18-495 Introduction to Biomedical Imaging and Image Analysis  
Fall: 12 units  
Bioimage Informatics (formerly Bioimaging) This course gives an overview of tools and tasks in various biological and biomedical imaging modalities, such as fluorescence microscopy, electron microscopy, magnetic resonance imaging, ultrasound and others. The major focus will be on automating and solving the fundamental tasks required for interpreting these images, including (but not restricted to) deconvolution, registration, segmentation, pattern recognition, and modeling, as well as tools needed to solve those tasks (such as Fourier and wavelet methods). The discussion of these topics will draw on approaches from many fields, including statistics, signal processing, and machine learning. As part of the course, students will be expected to complete an independent project.  
Prerequisite: 18-290.

18-499 Internship  
All Semesters  
The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is an internship, normally completed during the summer. Students do not need to officially register for an internship unless they want it listed on their official transcripts. ECE students interested in registering their internship for course credit on their transcript may request to be enrolled in this course. The ECE Undergraduate Office will add the course to the student’s schedule, and the student will be assessed tuition for 3 units. This process should be used by international students interested in Curricular Practical Training (CPT) or by any other engineering undergraduate wishing to have their internship experience reflected on their official University transcript. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE’s website.

18-510 Sensor Systems Design  
Spring: 12 units  
Please refer to the ECE webpage for a full description of this course. http://www.ece.cmu.edu/courses/18510  
Prerequisites: 18-401 or 18-402 or 18-419 or (18-320 and 18-310) or (18-320 and 18-300) or (18-320 and 18-310) or (18-310 and 18-391) or (18-310 and 18-391) or (18-391 and 18-300).

18-513 RF Circuits and Antennas for Wireless Systems  
Fall: 12 units  
The demand for wireless products is growing at an impressive rate. This interdisciplinary course will team students from electromagnetics with students from analog circuit design to explore the concepts of basic antenna design and measurement as well as RF transceivers. The students will have the opportunity to design and build transmitter or receiver subsystems, based on their application of interest. Designs may be done with discrete components for AM, FM and VHF (TV) receptions or with integrated components for UHF applications, such TV, wi-fi, etc. Integrated with these efforts will be the design of several types of widely used antennas. Students will design, construct, and test an antenna to meet stated specifications using a combination of theory, electromagnetic simulators and lab experiments. The focus of this course will be the construction of an antenna/transceiver system. In addition to the project, several lectures will be given to introduce students to the specific applications and to consolidate previous course materials as they apply to the project.  
Prerequisites: (18-300 and 18-320) or (18-402).

18-525 Integrated Circuit Design Project  
Fall: 12 units  
This course is intended to provide the electrical and computer engineering student with IC design experience. It solidifies the theoretical background and practical skills gained in 18320 and 18422. The primary stress of the class will be on the IC design process as a whole. Such a process, seen as a sequence of design decisions, must lead to a design which optimizes a given objective function under a number of constraints. The optimum design must be achieved using a number of variables involving all levels of design abstraction and ranging between architecture choice and detail of the IC layout. Typical design objectives adopted in class designs will be IC performance (throughput, power, signal-to-noise ratio, clock frequency, gain-bandwidth, etc.) and typical constraints will be die size and minimum feature size. The second most important objective of the class is to mimic a large design team environment in which individual designers must: (a) communicate precisely and efficiently his/her ideas and (b) utilize any feedback provided by the “design environment.” This objective will be achieved through class presentations given by each student and by stressing the importance of design documentation.  
Prerequisites: 18-320 and (18-340 or 18-341 or 18-310 or 18-450 or 18-491 or 18-415).
18-540 Rapid Prototyping of Computer Systems
Spring: 12 units
This is a project-oriented course which will deal with all four aspects of project development; the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class, in conjunction with the instructors, will develop specifications for a mobile computer to assist in inspection and maintenance. The application will be partitioned between human computer interaction, electronics, industrial design, mechanical, and software components. The class will be divided into groups to specify, design, and implement the various subsystems. The goal is to produce a working hardware/software prototype of the system and to evaluate the user acceptability of the system. We will also monitor our progress in the design process by capturing our design escapes (errors) with the Orthogonal Defect Classification (ODC). Upon completion of this course the student will be able to: generate specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided design tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. Senior standing is required.
Prerequisites: (18-348 and 18-320) or (18-349 and 18-320) or (18-340 and 18-341) or (18-349 and 18-320) or (18-341 and 18-349).

18-545 Advanced Digital Design Project
Fall: 12 units
In this capstone design project course, students will design and implement a large digital system with video output, sound output, and user input. The course will teach the technical skill to accomplish this, as well as enhance project planning and group management skills. To that end, students will participate in design reviews, weekly status reports, and final project presentations. The project will result in a working system implemented on an FPGA prototyping board. The completed projects will be shown in a public demonstration session at the end of the semester. Students should enter with a good grasp of computer architecture, Verilog programming, and hardware lab skills. Experience in FPGA programming, computer graphics, and/or VLSI design would also be useful. 4 hours lec., 24 hr. access lab
Prerequisites: 18-447 or (18-340 and 18-341) or (18-340 and 18-348) or (18-340 and 18-349) or (18-341 and 18-348) or (18-341 and 18-349) or (18-341 and 18-342) or (18-348 and 18-320) or (18-349 and 18-320)
Prerequisites: 18-447 or (18-340 and 18-341) or (18-340 and 18-349) or (18-340 and 18-342) or (18-341 and 18-348) or (18-341 and 18-349) or (18-341 and 18-342) or (18-348 and 18-320) or (18-349 and 18-320)
Prerequisites: 18-447 or (18-340 and 18-341) or (18-340 and 18-349) or (18-340 and 18-342) or (18-341 and 18-348) or (18-341 and 18-349) or (18-341 and 18-342) or (18-348 and 18-320) or (18-349 and 18-320)

18-549 Embedded Systems Design
Spring: 12 units
18-549 Embedded Systems Design This course comprises a semester-long project experience geared towards the development of skills to design realistic and practical embedded systems and applications. Students will work in teams on an innovative project that will involve the hands-on design, configuration, engineering, implementation and testing of a prototype of an embedded system of their choice. Students will be expected to leverage proficiency and background gained from other courses, particularly with regard to embedded real-time principles and embedded programming. The project will utilize a synergistic mixture of skills in system architecture, modular system design, software engineering, subsystem integration, debugging and testing. From inception to demonstration of the prototype, the course will follow industrial project practices, such as version control, design requirements, design reviews and quality assurance plans. The initial lecture content will cover background material intended to complement the project work. The remainder of the course will consist of regular team presentations of key project milestones, current project status, a final project presentation and functional demonstrations of various subsystems, even as the entire prototype is being developed. Please refer to the course website for more information: http://www.ece.cmu.edu/~ece549/Prerequisites: (18-348 or 18-349) and (15-211 or 18-320 or 18-370 or 18-391 or 18-340 or 18-341).

18-551 Digital Communication and Signal Processing Systems Design
Spring: 12 units
This course provides the student with a rich, in-depth design and application hardware project experience in the areas of digital communications and/or signal processing systems using DSP hardware. Teams of students work on a semester-long project of their choice. Topics include: speech and music processing, digital communications, multimedia processing, data compression, data storage, wireless communications, CD, image and/or signal processing, etc. One month of introductory laboratories familiarize the students with DSP hardware and support software. Lectures address z-transforms, IIR and FIR filter design using MATLAB and DSP hardware, LPC and adaptive filters, channel coding, time and frequency multiplexing, short-time Fourier and wavelet transforms, and spread spectrum techniques. 4 hrs. lec., 3 hrs. lab.
Prerequisites: 18-450 or 18-491 or (18-370 and 18-391).

18-578 Mechatronic Design
12 units
Mechatronics is the synergistic integration of mechanism, electronics, and computer control to achieve a functional system. Because of the emphasis on the hardware aspects, the course will center around system integration in which small teams of students will configure, design, and implement a succession of mechatronic subsystems, leading to a main project. Lectures will complement the laboratory experience with comparative surveys, operational principles, and integrated design issues associated with the spectrum of mechanism, electronics, and control components. Class lectures will cover topics intended to complement the laboratory work, including mechanisms, actuators, motor drives, sensors and electronic interfaces, microcontroller hardware and programming and basic controls. During the first week of class, each student will be asked to complete a questionnaire about their technical background. The class will then be divided into multi-disciplinary teams of three students. During the first half of the class, lab assignments will be made every 1-2 weeks to construct useful subsystems based on material learned in lecture. The lab assignments are geared to build to the main project. This course is cross-listed as 16-778 and 24-778. Students in other departments may take the course upon availability of slots with permission of instructor. Non ECE students may take the course upon availability of slots with permission of the instructor.
Prerequisites: (18-370 and 18-348) or (18-370 and 18-349) or (18-474).

18-610 Fundamentals of Modern CMOS Devices
Spring: 12 units
This course is intended to provide a foundation in device operation for circuit designers working in today's sub-micron CMOS. This course will also provide advanced understanding of CMOS technology for those interested in integrated circuit process technology and device physics. We review semiconductor device physics, including carrier dynamics and the basic equations of semiconductor device physics. The operation of the p-n junction diode is also reviewed. The course includes a description of integrated circuit fabrication technology and how it is used to fabricate CMOS devices. With this foundation, we then discuss the MOS transistor (including its application as a varactor). The theory of the MOS transistor will then be developed, followed by a discussion of important phenomena in sub-micron devices such as: velocity saturation; breakdown; drain-induced barrier lowering; random dopant fluctuations, etc. The student will learn the relationship between device geometry, e.g. length, and fabrication, e.g. doping, and the corresponding circuit performance. The course will primarily be lecture-based, with some selected simulation exercises. Students are expected to be acquainted with the basic concepts of electrical circuits; electromagnetic fields at the level of a sophomore level physics course, and to have adequate preparation in mathematics (basic differential equations and MATLAB or similar applications). Prior coursework in device physics is helpful but not required for graduate students. Lecture: 4 hrs Prerequisite(s): 18-310.
Prerequisite: 18-310.
18-615 Micro and Nano Systems Fabrication
All Semesters: 12 units
This course is intended to introduce students to the process flow and design methodology for integrated systems fabrication. The course will present this material through two paths: lectures will be presented on the basic unit processes of micro and nanosystems fabrication: deposition, patterning, and etching. Lectures will draw on examples from: Semiconductor device fabrication; Microelectromechanical systems (MEMS) fabrication; Magnetic device fabrication; and Optical device fabrication problem sets will be given based on this lecture material to allow students to quantitatively analyze certain process steps in detail. The second path for material presentation will be through a series of labs that allow students to design, fabricate and test an integrated device. These laboratories will be scheduled at regular meeting times, and will use research facilities within the ECE Department. 6 hrs. lec., 6 hrs. lab Prerequisites: 18-310, senior standing with instructor’s permission, or graduate standing. Prerequisite: 18-310.

18-617 Memory Devices and Systems
12 units
Prerequisite: 18-320.

18-623 Analog Integrated Circuit Design
Fall: 12 units
Some form of analog circuit design is a critical step in the creation of every modern IC. First and foremost, analog circuits act as the interface between digital systems and the real world. They act to amplify and filter analog signals, and to convert signals from analog to digital and back again. In addition, high performance digital cell design (either high speed or low power) also involves significant design issues. The goal of this course is to teach students some of the methods used in the design and analysis of analog integrated circuits, to illustrate how one approaches design problems in general, and to expose students to a broad cross-section of important analog circuit topologies. The course will focus on learning design through carrying out design projects. Design and implementation details of wide-band amplifiers, operational amplifiers, continuous-time filters, phase lock loops and data converters will be covered. The course will focus primarily on analog CMOS, but some aspects of BiCMOS design will be discussed. 4 hrs. lec. Prerequisites: 18-321 and senior or graduate standing. Prerequisite: 18-421.

18-649 Distributed Embedded Systems
Spring: 12 units
Embedded computers seem to be everywhere, and are increasingly used in applications as diverse as transportation, medical equipment, industrial controls, and consumer products. This course covers how to design and analyze distributed embedded systems, which typically consist of multiple processors on a local area network performing real time control tasks. The topics covered will include issues such as communication protocols, synchronization, real-time operation, fault tolerance, distributed I/O, design validation, and industrial implementation concerns. The emphasis will be on areas that are specific to embedded distributed systems as opposed to general-purpose networked workstation applications. This course assumes that students already know fundamental topics such as interrupts, basic I/O, and uniprocessor scheduling that are commonly taught in introduction-level embedded system courses such as 18-348 and 18-349. Any graduate student who has not taken one of the pre-req ises is responsible for understanding relevant material necessary for this course. Additionally, all students are responsible for knowing or learning on their own intermediate-level programming in Java. Prerequisites: 18348 or 18349 and senior or graduate standing. Prerequisites: 18-348 or 18-349.

18-712 Elements of Photonics for Communication Systems
Fall: 12 units
Please see the ECE website for a full course description of this course. Prerequisites: 18-300 and 18-310 and (18-402 or 33-439) and senior or graduate standing. Prerequisites: 18-300 and 18-310 and (18-402 or 33-439).

18-715 Physics of Applied Magnetism
Spring: 12 units
In this course we address the physics of magnetism of solids with emphasis on magnetic material properties and phenomena which are useful in various applications. Various applications of magnetism are used to motivate the understanding of the physical properties and phenomena. The content of this course includes the origins of magnetism at the atomic level and the origins of magnetic ordering (ferro-, ferrim-, and antiferromagnetism), magnetic energy, magnetic domains, domain walls, spin dynamics and electronic transport at the crystalline level. The principles of magnetic crystal symmetry, tensors, and energy minimization are utilized to explore magnetic properties such as resonance, domain structures, magnetocrystalline anisotropy, magnetostatic interaction, magnetization, and susceptibility. Phenomenological properties, such as the technical magnetization process, are used to describe mechanisms of coercivity, eddy current effects and losses, while energy minimization and relaxation are used to explain properties such as single domain particle behavior, memory mechanisms, magnetic aftereffects and thermal stability. Prerequisite: 18-300 or equivalent background in electromagnetic fields; Senior level solid state physics and materials, or the equivalent, and a senior or graduate student standing. Prerequisite: 18-300.

18-716 Advanced Applied Magnetism
Spring: 12 units
Over the past decade, magnetism has once again become one of the dominant themes in material science and solid-state physics. Today, the development of new thin film recording media and the discovery of giant magnetoresistance have resulted in the amount of stored bits in a single disk drive to reach astronomical numbers. Rapid advances in spin-polarized electrical transport have brought to the horizon a new kind of electronics, called spintronics, with a new functionality based upon the spin of the carriers. The newly enriched magnetism brings unbounded technologic opportunities, yet full of challenges. This course will cover many of the important technological applications of advanced magnetism. The emphasis will be placed on how the basic principles and concepts are applied. The topics include: (1) Application and theory of spin dependent transport: CIP and CPP GMR devices, spin injection in spinitors, spin LED, spin transistors, and spin current induced magnetic switching; (2) Engineering of the magnetic material properties for thin film recording media, recording heads, magnetoresistive random access memory; (3) Thermally excited ferromagnetic resonance: mag-noise in magnetic devices, and thermally activated magnetization reversal; (4) Continuous and patterned magnetic films: magnetic bubble technology and patterned media; (5) Magnetostriiction: magnetostriactive sensors; (6) Magnetic imaging techniques: magnetic resonance imaging (MRI), magnetic force microscopy (MFM), differential-phase-contrast microscopy (DPC), SEMPA, and Kerr microscopy. 4 hrs. lec. Prerequisite: 18-715 or equivalent upon instructor’s approval and senior or graduate standing. Prerequisite: 18-715.

18-765 Digital System Testing and Testable Design
Fall: 12 units
This course examines in depth the theory and practice of fault analysis, test generation, and design for testability for digital ICs and systems. The topics to be covered include circuit and system fault detection and testability issues; single stuck-line (SSL), delay, and functional fault models; fault simulation methods; automatic test pattern generation (ATPG) algorithms for combinational and sequential circuits, including the D-algorithm, PODEM, FAN, and the genetic algorithm; testability measures; test generation and scan design; test compression methods; logic-level diagnosis; built-in self-testing (BIST); VLSI testing issues; and processor and memory testing. Advance research issues, including topics on MEMS and mixed-signal testing are also discussed. 4 hours of lecture per week Prerequisites: 18-240 and 15-211 and (18-340 or 18-341) Senior or graduate standing required. Prerequisites: (15-214) and (18-240) and (18-340 or 18-341).

18-771 Linear Systems
Spring: 12 units
Engineering Public Policy Courses

19-101 Introduction to Engineering and Public Policy
Spring: 12 units
This course examines the processes of public and private decision making and of policy formation, which shape the evolution of a technology and its impact on our society. Technology plays an important role in shaping our worlds. At the same time, social forces often play a central role in the evolution of a technology. A particular technology such as an automobile or computer is chosen to study technology and policy in context. Specific topics covered in the case of the automobile include automotive design and manufacture, safety, pollution, fuel economy and their interactions. In each area, we discuss the technological and institutional issues, their interaction, the possible need for public policy and the factors that govern the policy. The course will involve several group problem-solving sessions. Corequisites: 33-106, 21-116, 21-115.

19-102 EPP Sophomore Seminar
Fall: 3 units
The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of case studies dealing with aspects of decision-making and ethics in policy issues which have a technological basis. Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are occasionally included to give the student an idea of careers and EPP problems.

19-201 EPP Sophomore Seminar
All Semesters: 3 units
The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of case studies dealing with aspects of decision-making and ethics in policy issues which have a technological basis. Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are occasionally included to give the student an idea of careers and EPP problems.

19-350 SP TP: Research Methods & Statistics for Engineering & Public Policy Analysis
9 units
This course synthesizes concepts from economics, statistics, decision analysis, and other humanities and social science areas as they relate to analysis of technology and public policy issues. Students will focus on applying skills, tools, and techniques of social science to critically examine issues of current importance to society that have engineering systems at the core, and how public policy can be informed by the results of these analyses. Students will discover the relationship between formulating research questions considering a wide range of perspectives (e.g., political, ethical, social, economic, and legal aspects) and implementing the appropriate methods for answering them. The course will emphasize interpretation and communication of analysis results in written and oral presentation, especially to non-technical audiences. As a precursor to the EPP Project courses, the course also prepares EPP juniors for structuring real-world problems into a feasible work plan, and to deal with revising work plans as work proceeds.

19-402 Telecommunications, Technology Policy & Management
Intermittent: 12 units
This course provides a comprehensive introduction to basic principles of telecommunications technology and the legal, economic, and regulatory environment of the telecommunications industry. Topics covered are: role of new technologies such as fiber, wireless, voice over packet, and broadband access; principles behind telecommunications regulation from common carrier law and natural monopoly to open access and interconnection; differences in the treatment of telecommunications versus information services. Also, mergers, antitrust, and the changing industrial structure of telecommunications; spectrum allocation and management; and international comparison of telecommunications regulations. Special emphasis on how the new technologies have altered and are altered by regulation. Prerequisite: 73-100.

19-403 Policies of Wireless Systems and the Internet
Intermittent: 12 units
This course will address public policy issues related to wireless systems, and to the Internet. It begins by investigating policies related to a wide variety of emerging wireless systems and technologies, including wireless computer networks, broadband to the home, broadcast radio and television, and satellite communications. This is to include the government role in facilitating the creation of infrastructure, in advancing competition among broadcasters and communications service providers, in managing spectrum, and in protecting privacy and security. The course will then address Internet policy issues, which can include Internet governance and the domain name system, taxation, privacy and security, and intellectual property. Because these are inherently interdisciplinary issues, the course will include detailed discussions of technology, economics, and law, with no prerequisites in any of these areas.

19-411 Global Competitiveness: Firms, Nations and Technological Change
Fall: 9 units
Global Competitiveness introduces students to the fundamental principles surrounding global competitiveness and technological change in the 21st century. The course is broken into three sections. The first section introduces students to competing economic, sociological, and political science theories on the structures supporting technological change. The second section presents the contemporary literature on technological change. The concluding section leverages lessons from the preceding two sections to evaluate national innovation systems, and the factors that lead to national comparative advantage. Students should leave the class able to reflect competently on what the existing literature tells us about the factors influencing global technology competitiveness, and on how modern changes in the structures supporting innovation as well as technology itself may be changing the rules of the game for firms and for nations. The course is open to undergraduate juniors, seniors & graduate students.

19-424 Energy and the Environment
Intermittent: 9 units
This course will explore the relationships between environmental impacts and the utilization of energy through a series of case studies on topics of current interest. Such topics might include the use of renewable and non-renewable fuels for electric power generation; energy use for automobiles and other transportation systems; energy use for buildings and industrial processes; and environmental issues such as urban air pollution, ozone formation, acid rain, and global warming. The emphasis will be on analysis of energy-environmental interactions and tradeoffs, and their dependency upon engineering design choices, economic variables, and public policy parameters.

19-426 Environmental Decision Making
Intermittent: 9 units
This course will cover a number of topics in environmental decision making, including risk perception, risk communication, risk ranking, multi-attribute utility theory, decision analysis, the "precautionary principle," the economics of environmental externalities, commons dilemmas, cost-benefit analysis, the valuation of health and environmental amenities, discounting, intergenerational equity, environmental justice, and sustainability.
19-430 Civilian and Military Applications of Space
Intermittent: 12 units
An analysis of some specific defense and space policy issues is conducted. This analysis is abstracted from a study of the specific technologies involved. An assessment of the impact of technological advancement on the military capability, space policy and arms control issues is proposed. As the exploitation of high technology has a lot of ramifications, the course focuses on some areas carefully chosen, based on the recent events, to illustrate the extent of the impact and to permit a wide-ranging discussion as possible. Those issues cover area of advanced imaging and target recognition capabilities; the military exploitation of new physical principles; the development of new capabilities in space for military or civilian exploitation, and the convolution of these new capabilities with the increasing technological demands of arms control. In all examples, the interaction between technological progress and needs for policy changes (or emergence of policy dilemmas) are emphasized.

19-440 Combustion and Air Pollution Control
Intermittent: 9 units
Formation and control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermocatalytic equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants in combustion systems. Combustion modifications and postcombustion technologies for pollutant control. Relationship between technology and regional, national, and global air pollution control strategies. The internal combustion engine and coal-fired utility boiler are used as examples.

19-443 Special Topics in EPP
Spring: 9 units
The idea of this course is to gain a good basic understanding of the ways in which climate change manifests in the world around us and affects human and natural systems. For each climate change impact considered we will explore possibilities of adaptation, drawing upon principles of robust decision making. We begin by reviewing the physics of the greenhouse gas effect. Next we survey large-scale natural climate variations such as ENSO and how these affect human societies. Based on this, we will look in some detail at the process of climate change detection, attribution and projection. In the second part of the course we explore how climate change is affecting specific features of the climate system and weather extremes. Here we consider temperature extremes, changes in precipitation, floods and droughts, hurricanes and the associated damages, and changes in the cryosphere (the earth's ice and snow covered surfaces). We will discuss vulnerabilities of human and natural systems in the face of these changes and explore adaptation strategies for each impact.

19-448 Science, Technology & Ethics
Intermittent: 9 units
Technology has always been a pervasive force in society. But the last century, and especially the last 50 years have seen an unprecedented acceleration of the growth and permeation of technology. The central role of technology and engineering in the modern world calls for a reflective examination of the responsibility of those who develop, deploy and spread technologies as well as those who avail of them for various purposes. This course will explore one technology of recent origin in detail – biotechnology. After examining the way people think about and deal with technological risk, the basic science behind the technology and the ethos of science and technology, the students will learn about the philosophical foundations of possible ethics for science and technology. Projects and discussions will explore how these foundations can be used to provide ways to frame important questions and develop an understanding of an ethic for the development and use of biotechnology.

19-451 EPP Projects
Spring: 12 units
Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-452 EPP Projects
Fall: 12 units
Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-500 Directed Study in EPP: Undergraduate
All Semesters
Students may do undergraduate research as one course for EPP technical elective credit, with an EPP faculty member, or on an approved project with a faculty member from another department. The research credits must be pre-approved by your advisor, and should result in a written product, one copy of which should be sent to EPP.

19-601 Information Warfare
Intermittent: 12 units
Information security is one major concern raised by the increasing use of computers in networks. In this course we first review, in some technical detail, the nature of the “threats”. These include viruses and worms (their history and how they “evolved”), backdoor exploits, Trojan horses, buffer overflows, and the extent to which they imperil the information in computers. Then we discuss the use and limitations of firewalls in protecting computer networks. We also discuss intrusion detection and the problems associated with it. We review past and present cyberattacks, like Denial of Service attacks, viruses such as Melissa and I love you, and assess their implications. We analyze the origin of computer vulnerabilities which make those attacks possible and discuss the extent to which they could be reduced. Finally, we analyze the response to this situation at the national, security and international level.

19-606 Special Topics: Civil Systems Investment Planning and Pricing
Intermittent: 12 units
Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-609 Public Policy and Regulation
Intermittent: 9 units
Regulations are a significant policy tool of government. How society and the economy will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/or benefits never being realized. This course will review the basics of regulatory policy and using historical examples, will explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives. Prerequisites: Basic statistics, economics, and quantitative methods.

19-611 Special Topics: Global Competitiveness: Firms, Nations and Technological Change
Intermittent: 12 units
This course introduces students to the fundamental principles surrounding global competitiveness and technological change in the 21st century. The past twenty years have seen dramatic changes in innovation ecosystems in the U.S. and internationally. Alone within the U.S., there has been a sharp decline in corporate R&D labs, matched by the global fragmentation of firm activities. At the same time growing linkages have been observed across institutional – firms, government labs, and universities – and national borders. These changes raise critical questions about the new rules of the game driving technological change in the 21st century. This course sheds insights into these questions through the lenses of competing economic, sociological, and political science theories on the structures supporting technological change. The course is broken into three sections. The first section introduces students to theories of the firm, bureaucracy, institutional economics, and social networks as competing frameworks within which to understand technological change. The second section presents the contemporary literature on the technological change, including creative destruction, dominate designs, industry life cycles, and networks of innovators. The concluding section leverages lessons from the preceding two sections to evaluate national innovation systems, and the factors that lead to national comparative advantage. Students should leave the class able to reflect competently on what the existing literature tells us about the factors influencing global technology competitiveness, and on how modern changes in the structures supporting innovation as well as technology itself may be changing the rules of the game for firms and for nations. The course is open to seniors and graduate students; also to juniors with instructor permission.
19-613 Industries and Technological Innovation: Positions, Paths and Progress  
Intermittent: 9 units  
This course provides an introduction to the exciting area of technological innovation. It will reflect an applied, industry oriented approach, and will emphasize empirical studies. The essence of the course revolves around a comparative analysis of how different industries develop, manage and disseminate new technologies. These will include software and the internet, automotive, semiconductors, biotech, chemicals, steel, and others. A wide range of issues will be covered, including what is product and process innovation, the role of intellectual property, coping with radical vs. incremental change, the management of knowledge, etc. The course will focus on specific industries and particular technologies, but no particular background in each technology is required for participation.

19-614 Environmental Life Cycle Assessment and Green Design  
Spring: 6 units  
Cradle-to-grave analysis of new products, processes and policies is important to avoid undue environmental harm and achieve extended product responsibility. This mini-course provides an overview of approaches and methods for life cycle assessment and for green design of typical products and processes. Process-based analysis models, input-output and hybrid approaches are presented for life cycle assessment. Example software programs are used in assignments. A life cycle assessment project is required. Prerequisite: senior standing in engineering or permission of the instructor.

19-616 Case Studies in Sustainability Engineering  
Spring: 6 units  
The principles and tools of sustainability have yet to be applied on a large scale to solving real-world engineering problems. In this course, we explore the use of these principles and tools to various case studies. Prerequisites: 12-712 or 12-714 or 19-614 or 19-622.

19-622 Introduction to Sustainable Engineering  
Fall: 6 units  
Society has generally assumed that the earth’s resources are limitless and wastes can be disposed of without serious consequences, but the validity of these assumptions is now being challenged. This course begins with an overview of the concept of sustainability and its history, including changing attitudes and values toward technology and the environment through the twentieth century. Key conferences and reports that helped define sustainability are reviewed. Models for population growth, global food production, and global water resources are then presented, and current problems of land use, urbanization, and energy and material resources are discussed. Overall, the course material provides a context for engineering decisions in the twenty-first century, which are quite different from decisions of engineers in the past. Prerequisite: senior standing in engineering or permission of the instructor.

19-623 Industrial Ecology and Sustainable Engineering Design  
Fall: 6 units  
This course uses the context established in 12-712 / 19-622 to explore the solution space of engineers in tackling basic problems facing human civilization. The course begins with the concept of a system, using the earth’s life support system as an example. The potential damage of conventional engineering decisions on these life support systems is discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Finally, the principles and tools of sustainable engineering are used to explore solutions to some of the most challenging problems identified in 12-712 / 19-622. Prerequisites: 12-712 or 19-622.

19-644 Medical Devices  
Intermittent: 9 units  
This course is an introduction to the engineering, clinical, legal and regulatory aspects of medical device performance and failure. Topics covered include phenomenological and mechanistic descriptions of processes such as wear, corrosion fatigue and fretting, in addition to the characterization of bone and other biological materials as it relates to device performance requirements, including biocompatibility. The course also involves case studies of orthopedic fixation devices and prostheses, pacemakers, heart valves and artificial organs. A major portion of the course is a final design project which involves the design of a new medical device or the redesign of an existing device.

19-650 Climate and Energy: Science, Economics and Public Policy  
Intermittent: 9 units  
The climate problem ties energy policy to the geosciences in one of the central environmental dilemmas of the new century. How much will the planet warm? Can we avert climate change without wrecking our economy? The political and economic stakes are high. We will first explore the science of climate change through study of simple physical models of the atmosphere and climate. Topics will include models of atmospheric radiation and of the verticle and latitudinal temperature structure of the atmosphere. In the latter half of the course we will focus on energy policy through study of the engineering and energetic constraints on industrial systems. Topics will include primary energy sources, energy conversion technologies, and energy economics and policy. Throughout the course we will alternate between lectures that survey the key topics and detailed examples that require student involvement. Analysis of the energy flows and transformations will serve as a unifying theme for the course.

19-662 Special Topics: Technology and Development in China & India  
Intermittent: 12 units  
This course will explore the role of technology and economic development in India and China. It will open with three lectures that provide a theoretical framing for the course drawing broadly on the literature in economics and technical innovation. The balance of the semester will consist of a set of classes on the role of technology and innovation in India followed by a parallel set on China. The course will conclude with some cross-comparison between the experience and prospects in both nations. The course is open to undergraduates and graduate students. Students will be expected during each class to demonstrate mastery of individual concepts through in-class participation and occasional in-class quizzes on the assigned readings. Students will in addition choose a topic of interest to which to apply concepts in the form of three paper assignments across the duration of the course. These three paper assignments will include two mid-term assignments, one on India and one on China, and a final term paper building on the previous two papers to compare lessons across the two countries.

19-680 E&TIM Seminar on Innovation Management in Practice  
Intermittent: 3 units  
Innovation has been described as "the intersection of invention and insight, leading to the creation of social and economic value." Companies increasingly rely on innovation to establish and drive their success. Public policy makers see innovation as a critical driver for economic development. This course is an opportunity to learn about innovation management from those in the front lines. How are innovation opportunities identified? What are the challenges to realizing these opportunities, and how can the challenges be addressed? What roles are played by processes, technologies and the business environment, as well as by individuals in organizations? This course will feature speakers who drive innovation in a variety of settings, paired with readings from the innovation literature that will help frame the presentations and discussion.

19-681 Managerial and Engineering Economics  
Intermittent: 12 units  
The course emphasizes the application of economic principles (e.g., marginal analysis, supply and demand, competitive equilibrium, imperfect competition and monopoly) and scientific principles (e.g., quantifying costs and benefits, net present value, decision making under uncertainty) to managerial decision making. Topics include production costs and revenues, elements of decision analysis, market mechanisms, pricing decisions, information economics. The coverage of these topics fosters an understanding of the organization of firms and markets and firm decision making in the context of exploring, evaluating, and managing opportunities for technological innovation and diffusion.

19-682 The Strategy and Management of Technological Innovation  
Intermittent: 12 units  
The course on Strategy and Management of Technological Innovation prepares professionals with technical and scientific backgrounds for managing technology within an organization and the broader strategic decision-making required at the corporate level. This course teaches how an appropriate incorporation of technology and innovation into corporate strategy and management can lead the firm to achieve profitable and sustainable competitive advantage. It addresses the role of technology management in both emerging and established firms, and examines how all of the firm’s activities, assets, and relationships must complement one another in order to capture value from innovation. The course examines frameworks, models and tools essential for those actively engaged in the innovation process within a firm and apply these to case studies illustrating their importance in technology industries.
19-687 Principles and Practices of R&D Management  
Intermittent: 6 units  
This course considers key issues and trade-offs in R&D strategy and organization, paying attention to dynamic competitive contexts where technology plays a key role. These topics are treated using the perspective of the decision maker. It addresses typical problems of large, medium and small firms having a structured R&D and operating businesses where R&D is the source of competitive advantages. Although we will heavily focus on R&D, emphasis is placed on viewing R&D as a part (although, a key part) of the process of technological innovation; therefore, as an activity to be strongly and appropriately integrated with other functions to make innovation successful.

19-688 Innovation for Energy and the Environment  
Intermittent: 12 units  
Issues in energy and the environment may be framed in different ways. Engineers may describe a technical system while social scientists may choose policy terms. To these views, this course adds the business and innovation dimensions, which provide additional motivation for change in these dynamic areas. The class will explore opportunities for economic, environmental and social value creation for several cases, each of which has its own set of considerations for resources, stakeholder perspectives, business challenges and technical opportunities. The course will emphasize utilization of methods, tools and frameworks to describe and evaluate potential innovation opportunities in the energy and environmental sectors. Upon completion of the course, students should be able to evaluate the economic and environmental aspects of business decisions in these sectors, and know how to assess possible adoption paths, impacts and benefits.

19-693 Managing and Leading Research and Development  
Intermittent: 12 units  
Please refer to the description for ECE course 18703 at http://www.ece.cmu.edu/courses/18703. The EPP number is a cross listing of this same course.

19-699 Special Topics: Institutions Entrepreneurship and Inovation  
Intermittent  
Institutional environment and public policy greatly affect incentives determining the direction of entrepreneurial activity and innovation that are the engines of economic growth. In societies with poor institutions, entrepreneurial talent is most directed towards seeking rents rather than generating productive innovations. But even in modern capitalist economies entrepreneurial activity and innovation are strongly influenced by public policies, for example, those related to intellectual property rights. This course seeks to provide students with analytical frameworks that will enable them to understand how various formal and informal institutional arrangements and public policy decisions influence entrepreneurial activity and innovation and how this, in turn, affects economic efficiency and growth potential of nations.

19-701 Introduction to the Theory and Practice of Policy Analysis  
Intermittent: 12 units  
This course reviews and critically examines a set of problems, assumptions and analytical techniques that are common to research and policy analysis in technology and public policy. Topics covered include the difference between science, cross-science and policy analysis, policy problems formulated in terms of utility maximization, issues in the valuation of intangibles, uncertainty in policy analysis, selected topics in risk analysis, limitations and alternatives to the paradigm of utility maximization, issues in behavioral decision theory, issues related to organizations and multiple agents, and selected topics in policy advice and policy analysis for the federal government. The objective is to look critically at the strengths, limitations and underlying assumptions of key policy research and analysis tools and problem framing and sensitize students to some of the critical issues of taste, professional responsibility, ethics, and values that are associated with policy analysis and research.

19-702 Quantitative Methods for Policy Analysis  
Intermittent: 12 units  
Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-703 Survey, Design and Analysis  
Intermittent: 6 units  

19-704 Applied Data Analysis  
Intermittent: 6 units  
Applied Data Analysis is a course that will cover several statistical procedures, including multiple regression with interactions, logistic regression, signal detection analysis, principal components analysis, factor analysis, and possibly other techniques, with an emphasis on hands-on data analysis.

19-705 Workshop Applied Policy Analysis  
Intermittent: 6 units  
The course is designed to provide experience in setting up, analyzing, and writing about policy problems of the type that are used in the EPP Part B qualifying exam. Over the course of the semester, the class works through six or seven policy case problems. Much of the work is done in small groups. The principal focus is on integrating the qualitative and quantitative aspects of the problems and on identifying and practicing general problem-solving strategies.

19-752 EPP Project Management  
Fall and Spring: 12 units  

English Courses

76-100 Reading and Writing for an Academic Context  
Fall and Spring: 9 units  
76-100 is an academic reading and writing course for multilingual students, especially those who are not native speakers of English or who consider English to be their weaker language. The course, designed as a prerequisite for 76-101, emphasizes reading comprehension strategies for reading a variety of text types in English (e.g., journalism, textbook selections, popular press arguments, and academic journal articles). Throughout the semester, students use these sources to write summaries and short position papers. The course introduces students to readers’ expectations for North American rhetorical style at the sentence, paragraph, and whole text or genre levels. Within the course we discuss explicit genre and linguistic norms for writing in academic English so that writers can connect with their readers. Students who take this course qualify through an online placement test that is administered through the university prior to the fall semester. (All sections are offered MWF). Each 76-100 course is structured by the reading and writing objectives of the course as well as a vocabulary or topic for writing in English, but some courses present different themes (or content) in their readings.

76-101 Interpretation and Argument  
All Semesters: 9 units  
76-101 introduces first-year students to an advanced, inductive process for writing an argument from sources. Because the course is based upon empirical research about professional academic writers, students can expect to learn expert practices for authoring their own arguments that contribute to an existing community of authors. Because reading and writing are inseparable practices for academic writing, students will read a variety of texts so that they can explore and critically evaluate a single issue from multiple perspectives and from different disciplinary genres. Students can expect to learn methods for summarizing, synthesizing, and analyzing arguments within that issue so that they may contribute an argument of their own. The course is also geared toward helping students understand the requirements of advanced college-level writing. Our students are typically very accomplished readers and writers, and we are eager to push their accomplishments toward greater excellence. For this purpose, students will build upon their composing knowledge by reflecting and thinking strategically as they plan, write, and revise their own texts. Ultimately, they will develop critical reading, rhetorical and linguistic practices for analyzing and producing texts within the context of an academic community. Each section of 76-101 is structured by the same objectives and core assignments. There is a core vocabulary and set of heuristics that all sections teach. However, students may find particular issues more interesting or appealing than others—we encourage students to pursue their interests, but we also ask that students engage any 76-101 course with intellectual curiosity. Due to the limits of our schedule, we are unable to meet each student’s individual preferences for course topics, but we do offer a wide variety from which to choose.

76-143 Freshman Seminar  
Intermittent: 9 units  
Topics vary by semester. Spring 2011: Performance studies emerged in the 1980s as a new, interdisciplinary field that combines interpretive strategies and analytic methods from theatre studies, anthropology, linguistics, and critical theory. Gender studies focus on how we understand the world around us through masculinity and femininity as variable, cultural constructions. This seminar will introduce students to key readings in these two interdisciplinary fields and give them practice in collecting and interpreting data about embodied, gendered performances.
76-144 English Freshman Seminar
Fall: 9 units
Topics vary by semester. Fall 2012: Through weekly readings, presentations, and writing exercises students will explore the ways in which humor, politics, gender, spirituality, cross-genre collaboration, and historical events influence the work of contemporary black poets. Students will respond to "Arcade, the bi-coastal collaborative book of two women - a poet and visual artist - and to various writings, which exhibit the hybridization of poetic forms, literary genres, and visual art. The collected essays of poet, scholar, and recent inaugural poet, Elizabeth Alexander, will anchor us during class discussions. No previous creative writing experience is required. Students need only arrive with an open mind as we encounter playful and mysterious locations and neologisms like Harriette Mullen's "burly mugs" and Wanda Coleman's "buddhaflies.".

76-145 Freshman Seminar
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Fall 2011: What does it mean to be Indian outside of India? How is it possible to "live in the hyphen" as both British and Pakistani? In this course we will look at the writings and experiences of South Asians (people from the Indian subcontinent), living in such places as the United States, Britain, the Caribbean, the Middle East, and East Asia, who construct what Salman Rushdie calls "imaginary homelands." We will examine the histories of migration and study how the experience of living between two continents has been theorized. In addition to examining the diaspora's past, the course will investigate present day South Asian diaspora cultures including popular culture, film, music, dance, art, theater, and literature. Possible readings include works by V.S. Naipaul, Salman Rushdie, Jhumpa Lahiri, Hanif Kureishi, Meera Syal, Vijay Prashad, and Michael Ondaatje.

76-213 19th Century British Literature
Intermittent: 9 units
Topics vary by semester. Spring 2012: Women writers played an essential role in the construction of Victorian literary culture. In this course we will read novels, poems, and periodical extracts by a diverse body of nineteenth-century female authors as a means of better understanding women’s historic and aesthetic impact on Victorian culture. While some of our authors are well known, like the widely popular poet Elizabeth Barrett Browning, we will also encounter the 'lost' author, journalist, and controversial anti-feminist Eliza Lynn Linton. The writing of Victorian women exemplifies important social debates from the nineteenth-century. Social taboos such as divorce, suffrage, Bloomerism, children out of wedlock, and women in the workforce were all topical in Victorian culture. As the conflicted and introspective heroine of George Eliot's The Mill on the Floss reminds readers, the role of marriage as a woman's sole profession was becoming increasingly untenable for Victorians. We will ask what other function were women fit to occupy. From the Pre-Raphaelite poetry of Christina Rossetti, to the gothic horror of Emily Bronte’s Wuthering Heights, “the woman question” served as a lightening rod for a variety of nineteenth-century cultural anxieties. The central question which we will encounter in Mary Elizabeth Braddon's Lady Audley's Secret was an especially controversial aspect of the female-dominated genre of “Sensation Fiction.” Margaret Oliphant records in an 1867 review from Blackwoods: "What is held up to us as the story of the feminine soul as it really exists underneath its conventional coverings is a very fleshly and unlovely record."(See Dept. for full desc.).

76-215 19th Century American Literature
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2010: In this class, we will be reading many of the major works of Edgar Allan Poe, Nathaniel Hawthorne, and Herman Melville. Often described as America’s Dark Romantics, these three authors are frequently read as reacting to the current of optimism and idea of human perfectibility that characterized antebellum America and the Transcendentalist movement. We will begin by reading most of Poe’s short fiction and novelettes and a number of his poetic and journalistic works. We will also read Hawthorne’s two major novels House of the Seven Gables and The Scarlet Letter, as well as a number of his shorter works from Twice-Told Tales. The class will also look at a number of Melville’s major works beginning with his first novel Typee, his short story collection The Piazza Tales, and culminating with Moby Dick. In addition to reading these canonical authors for their artistic merit, we will also consider the ways in which their works interacted with some of the prevailing ideas of their historical moments.
Prerequisite: 76-101.

76-217 Contempory American Literary & Cultural Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Summer 2010. It has been said that the teenager is the most free and least happy of all living beings. Given America’s current obsession with youth culture, it’s hard to imagine a time when the word "teenager" did not exist. However, this word came into being largely as a result of the post World War II boom in consumerism when advertisers needed a new way to define an emerging demographic group with its own disposable income and spending power. Through a survey of twentieth century literature that focuses on the teenage experience, we’ll explore the changing meanings of young adulthood over the last one hundred years. What is the relationship between the invention of the teenager and modernist aesthetics? What characteristics were considered markers of young adulthood in the 1920s? In the 1950s? In 2000? How are the experiences of angst, anomie and the unfulfilled American dream connected to modern Western life through the teenage subject? How do tropes of individualism, rebellion, freedom and resistance connect the literature of teen angst with other genres of American literature? How has angst been both an impediment to and the inspiration for cultural resistance and social change? To answer these questions, we will compare texts such as Philip Roth’s Portnoy’s Complaint, Anzia Yezierska’s The Bread Givers, J.D. Salinger’s Catcher in the Rye, Margaret Atwood’s The Edible Woman, Dave Eggers’ A Heartbreaking Work of Staggering Genius, and Banana Yoshimoto’s Kitchen. See English Department for full description.
Prerequisite: 76-101.

76-221 Studies in Classical Literature: Books You Should Have Read By Now
Intermittent: 9 units
May it seem more and more difficult to get a good classical, liberal education these days. The demands of professional training force many of us to skimp on our understanding of major artistic achievements. So, this class is for those people who should have read some of the best books around, but haven't managed to yet—books you should have read by now. Kurt Vonnegut’s character Kilgore Trout sings the praises of Dostoevsky’s The Brothers Karamazov, pointing out that it contains everything you need to know about life. He then ruefully adds that unfortunately that’s not enough anymore. It may not be enough, but it might be a place to start. Each book will be considered in itself for whatever it might offer by way of understanding the world, then and now. Each one can be seen as a useful foundation point for understanding an important period of history (Machiavelli and the Renaissance, for example). Finally we shall use the idea that literature is equipment for living as a way of understanding and evaluating our experiences.

76-225 Topics in Rhetoric
Intermittent: 9 units
Topics vary semester to semester. Consult Department for most recent topic. Summer 2012: This course interrogates the identity of the US military and its members through media representation, and how that identity affects rhetorical situations involving US military and civil relationships. After a sociolinguistic examination of how military members create identity, and are in turn represented in media, we'll look for implications of that identity in real world contested issues. For example, how do identities like soldier and Marine affect decisions to allow women to serve in combat, or gay, lesbian and transgendered citizens to serve as military members? How do popular, influential works like the book and mini-series Generation Kill, or the Turkish film Valley of the Wolves address and impact rhetorical situations like the Abu Ghraib torture? In addition to course readings and discussions, students in 76-3XX will be asked to analyze and then synthesize journalistic, literary, and critical sources in a short interpretive paper, and then a longer research paper that addresses an issue topical to the course.

Course Rational: This course fills several English department programmatic needs. It is an introduction to the importance of understanding the world, then and now. Each one can be seen as a useful foundation point for understanding an important period of history. Summer 2012: This course interrogates the identity of the US military and its members through media representation, and how that identity affects rhetorical situations involving US military and civil relationships. After a sociolinguistic examination of how military members create identity, and are in turn represented in media, we'll look for implications of that identity in real world contested issues. For example, how do identities like soldier and Marine affect decisions to allow women to serve in combat, or gay, lesbian and transgendered citizens to serve as military members? How do popular, influential works like the book and mini-series Generation Kill, or the Turkish film Valley of the Wolves address and impact rhetorical situations like the Abu Ghraib torture? In addition to course readings and discussions, students in 76-3XX will be asked to analyze and then synthesize journalistic, literary, and critical sources in a short interpretive paper, and then a longer research paper that addresses an issue topical to the course.

Course Rational: This course fills several English department programmatic needs. It is an introduction to the importance of understanding the world, then and now. Each one can be seen as a useful foundation point for understanding an important period of history.
tragedy, even if—or especially—because it tends to favor the superficial definition of the comic, but for our purposes we can consider it as an
Intermittent: 9 units
76-227 Comedy
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2012: The purpose of this course is to introduce you to diverse examples of African-American literary expression. You will read canonical works like Frederick Douglass’ Narrative of the Life of Fredrick Douglass, an American Slave, Zora Neale Hurston’s Their Eyes Were Watching God and Toni Morrison’s Sula as well as not so canonical but more contemporary works like Aaron McGruder and Reginald Hudlin’s graphic novel Birth of a Nation, Kyle Baker’s comic-series Truth: Red, White and Black and Paul Beatty’s Tuff. Along with these primary works this course will also introduce you to the field of African-American literary criticism. These secondary readings will help you explore the historical, aesthetic and political issues that surround these works of art, give you a sense of how criticism functions and the multitude of forms it can take.
Prerequisite: 76-101.

76-232 20th Century American Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Example, Fall 2010: 20th Century American Bestsellers: In this course we will work to construct a story about the United States and its literary tastes in the twentieth century by reading a selection of bestselling American fiction from the last 100 years. The class will introduce students to concepts central to the cultural study of popular texts, as well as a number of more and less familiar authors and novels. Readings will include only novels that appeared on yearly Publisher’s Weekly top-ten bestsellers lists from 1900 to 1975. Winston Churchill’s A Far Country, Edith Wharton’s The Age of Innocence, Margaret Mitchell’s Gone with the Wind, Sloan Wilson’s The Man in the Gray Flannel Suit, J. D. Salinger’s Franny and Zooey, and E. L. Doctorow’s Ragtime are just a few of the novels that have shown up on this list. To complete our sketch of popular contemporary fiction, students will present on a bestseller from the last three decades and its reception. Moving through the wide range of texts that became bestsellers, from Wharton to Dan Brown or Stephen King, will allow us to consider whether Daniel J. Boorstin really got the whole story. Our class will also explore various “dead media,” technologies that got left behind in the march of progress towards the digital. By approaching the very idea of new media critically, the class intends to deepen students’ understanding of both the historical and contemporary position of the digital media we rely upon to interact with the world around us. While the course readings will be comprised primarily of theoretical and historical approaches to media, we will also draw off many primary sources such as science-fiction, classics of American literature from writers such as Walt Whitman and Thomas Pynchon, as well as documents in which technical pioneers such as Alan Turing outline the form and function of concepts and devices that directly shape modern day computing. Since this course will cover multiple forms of media, students will be expected to develop methods to deal with the specifics of each medium. Students will keep media journals chronicling their interaction with various forms of media - new and old - and experiment with a small sample of digital archives and digital production software in order to complete a case study midterm project on an overlooked medium (or aspect of a medium) of their choice.
Prerequisite: 76-101.

76-238 Media and Film Studies
Intermittent: 9 units
Topics will vary by semester. Fall 2012: New media isn’t new; old media isn’t dead. The term “new media” itself presumes that a wholly original technology replaces another outdated one. This course will trace a history of media change from 1844 to the present day, or, roughly from the telegraph to the iPad, though we will dedicate the bulk of our attention to the mid to late twentieth century. Rather than accept a straightforward linear narrative of innovation, we will, instead, privilege use, reception, and context. The class will also explore various “dead media,” technologies that got left behind in the march of progress towards the digital. By approaching the very idea of new media critically, the class intends to deepen students’ understanding of both the historical and contemporary position of the digital media we rely upon to interact with the world around us. While the course readings will be comprised primarily of theoretical and historical approaches to media, we will also draw off many primary sources such as science-fiction, classics of American literature from writers such as Walt Whitman and Thomas Pynchon, as well as documents in which technical pioneers such as Alan Turing outline the form and function of concepts and devices that directly shape modern day computing. Since this course will cover multiple forms of media, students will be expected to develop methods to deal with the specifics of each medium. Students will keep media journals chronicling their interaction with various forms of media - new and old - and experiment with a small sample of digital archives and digital production software in order to complete a case study midterm project on an overlooked medium (or aspect of a medium) of their choice.
Prerequisite: 76-101.

76-241 Introduction to Gender Studies
Intermittent: 9 units
This course, required for a minor in gender studies, is designed to provide you with basic skills in reading about and understanding gender as a fluctuating and problematic category for understanding identity, behavior, and community. We will read theory from and about twentieth-century, “second-wave” feminism in order to understand something about the immediate history of this category, as well as more recent understandings of gender, such as queer and transgender revisions of the term. Case studies, derived from students’ individual interests, will be an important part of our process in understanding the theory.

76-245 Shakespeare: Histories and Tragedies
Spring: 9 units
We will be reading eight plays—three histories from early in Shakespeare’s career and five tragedies from later—and some essays on tragic drama. We will try to see these plays: 1) in relation to the culture for which they were written and which they helped shape—the newly established public theater in London, prevailing notions about social class and gender, Puritan attacks on play-going, and the like, and 2) in terms of “what’s in it for us”—how current audiences and readers can enjoy and interpret these plays. We will be considering what the plays have to say about the authoritative institutions and discourses of their time, and how they address us now that those institutions and discourses have been replaced by others. Students will be required to attend and participate regularly, submit blog responses to Blackboard, write three prepared essays, and take a final exam.
76-247 Shakespeare: Comedies and Romances
Fall: 9 units
Most of Shakespeare's comedies were written early in his career. The laughter they provoke is both festive and satirical, and they end in marriages. The darker (but more fantastic) plays we call romances were among the last drama he wrote. In this course we will be working out close readings of six very different representatives of the genre comedy and two from the romance genre. Two inquiries will guide our discussion: how did these plays address their audiences in the 1590s and early seventeenth century, and why do they still entertain us and claim our serious attention?

76-260 Survey of Forms: Fiction
Fall and Spring: 9 units
Fall 2012 Section A: This is an introduction to the reading and writing of fiction designed as the first in a sequence of courses for creative writing majors and also as a general course for students wanting some experience in creative writing. Character development and the creation of scenes will be the principal goals in the writing of a short story or stories during the course of the semester—to a minimum of 15 pages. Revisions will be important and reading assignments will illustrate the different elements of fiction reviewed and practiced. A journal is required and two quizzes on the reading material. Fall 2012 Section B: This course introduces students to the forms of fiction. Students will read a variety of short stories, and one novel, complete a series of exercises, and be asked to write their own story at the end of the course. We will focus on learning point of view options, plot, sense of place, and above all, the work of making a memorable character. Students will come to understand how to create a vivid scene that springs to life on the page, by learning to use fresh language in dialogue and description. Assignments will be completed in a series of drafts; students will learn to revise, line by line. The readings will be literary fiction; if you are a student who reads fantasy and science fiction exclusively, the readings of this course will likely not appeal to you. The class will be run, primarily, as a discussion, and demands daily attendance.
Prerequisite: 76-101.

76-261 Survey of Forms: Creative Nonfiction
Intermittent: 9 units
The National Endowment for the Arts defines "creative nonfiction" as "factual prose that is also literary." In this survey course, students will read a wide range of work that falls into this lively genre, including memoir, travel writing, the personal essay, and nature writing. Weekly writing assignments will give students the chance to work on short pieces of their own creative nonfiction.
Prerequisite: 76-101.

76-262 Survey of Forms: Nonfiction
Intermittent: 9 units
According to The National Endowment for the Arts, creative nonfiction is "factual prose that is also literary." Memoir, the essay, and literary journalism are just three kinds of writing that fit into this very broad, very vital genre. While creative nonfiction often borrows techniques from fiction, such as narrative, scene, dialogue, and point of view, creative nonfiction is based on actual events, characters and places. What distinguishes creative nonfiction from journalism is that it conveys more than bare-bones facts and that language, analysis and narrative voice are integral parts of each piece. In this course, students will have the chance to read widely within the genre. Exercises and writing assignments will give students the chance to write their own pieces, so that by the end of the semester, everyone will have written four different kinds of creative nonfiction.
Prerequisite: 76-101.

76-265 Survey of Forms: Poetry
Fall and Spring: 9 units
Section A, Fall 2012: Survey of Forms: Poetry is a course in the writing of verse. Students will study the traditions of English and American poetry. There are weekly reading and writing assignments. Additionally there are hour examinations and the submission of a final project to consist of all work completed during the course. Presence in class is mandatory, as is participation in class discussion and attending evening performances by visiting writers. Section B, Fall 2012: This course will introduce students to the elements of poetic craft through the study and practice of a range of poetic forms. In addition to composing brief verse poems, students will also organize independent and group presentations. Students will practice some workshopping of the poems written for class. Near the end of the semester, students are required to submit a final project that demonstrates a revision of poems they’ve written during the course.
Prerequisite: 76-101.

76-269 Survey of Forms: Screenwriting
Intermittent: 9 units
It is not so difficult to learn the format or even to master the style of the screenplay—the challenge lies in writing image-driven stories with believable dialogue, vivid characters, and a coherent, well-structured plot. To that end, students will view short and feature-length films, paying special attention to such fundamentals as character development and story structure. Students will read screenplays to see how scripts provide the blueprints for the final product, and write analytical papers. To gain experience and confidence, students will work on a number of exercises that will lead them toward producing a polished short screenplay by the end of the semester.
Prerequisite: 76-101.

76-270 Writing for the Professions
Fall and Spring: 9 units
Writing in the Professions is a writing course specifically designed for juniors and seniors in all majors other than English. The course is appropriate for upper-level students in all CMU colleges, has no writing prerequisites, and assumes that you may not have had much college-level writing instruction past your freshman year. The basic idea of the course is to give you experience in developing the writing skills you will be expected to have as you make the transition from student to professional. The course will cover resume writing, proposal writing, writing instructions, the difference between writing for general and specific audiences, and analysis of visual aids in various texts. The course requires that students work both independently and in groups.
Prerequisite: 76-101.

76-271 Introduction to Professional and Technical Writing
Fall and Spring: 9 units
Non-majors: Please see listing for 76-270 Writing for the Professions, a closely related course designed for and open to non-majors. Introduction to Professional and Technical Writing is designed specifically for declared majors in Professional or Technical Writing. The main work of the course is a series of five situation-based writing assignments spread over three broad and often overlapping areas - business/professional writing, media writing, and technical writing. Typical assignments include resumes, instructions, proposals, and adaptations of specialized information for non-expert audiences. At least one of the assignments will be a group project. As a final project, you'll create a portfolio of polished writing samples that you can use in applying for internships and employment. The range of assignments in the course is designed to give you experience with a variety of writing situations that professional writers frequently encounter. The assignments also reflect options for specialization that you may wish to pursue in future coursework and in your career as a professional writer. As you work through the assignments, you should learn both current conventions for the kinds of writing you'll be doing and a broadly applicable procedure for analyzing novel situations and adapting conventional forms (and creating new ones) to meet the unique demands of each new situation and task.
Prerequisite: 76-101.

76-272 Language in Design
Fall: 9 units
Language in design is a professional communications course for designers. During your career as a designer, you will be expected to produce written documents to supplement and accompany your design processes and solutions. In this course, you will learn the conventions associated with the types of writing that designers most often have to produce on the job, such as proposals, memos, and reports. Additionally, you will prepare a job packet (including a resume, a cover letter, and a portfolio) that you can use as you begin your job search. You will also refine your ability to talk about your projects to both expert and non-expert audiences. Ultimately, this course aims to prepare you for the professional communications situations that you will encounter in your design career. Enrollment is limited to majors from the School of Design.
76-273 Presenting a Public Self
Intermittent: 9 units
Presenting your work and ambitions in public forums is a skill that you will be expected to demonstrate as you emerge from undergraduate studies and prepare to enter the commercial sector, graduate-level academic work or professional education in business, medicine or law. While such expectations exist, practice in this genre of writing, particularly in the personal statement, is not always readily available in existing coursework. *Presenting a Public Self* will introduce methods for developing and practicing your ability to communicate individual proficiencies and aspirations in written form, while bringing you in contact with a body of published work by public intellectual figures from the U.S. and other territories whose writing demonstrates an intertwining of personal narrative and public, professional identity, to engage readers of all stripes. Throughout the term you will practice writing in the public yet personal vein through assignments like: self-portrait essay, to cultivate a first-person voice, an op-ed essay, to practice balance in argument from the position of a burgeoning expert in your disciplinary area, and a personal statement, where you will learn to combine articulation of a personal narrative and professional competency to argue why you are a strong candidate for a particular opportunity. Reading selections for the semester will include work produced by your peers, as well as published writers whose work combines personal and professional spheres, ranging from texts like Paul John Eakin’s Living Autobiographically to Mary Catherine Bateson’s Composing a Life to Spencer Nadler’s *The Language of Cells: A Doctor and his Patients, amongst others.*
Prerequisite: 76-101.

76-276 Genre Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Fall 2012: Poe defined the short story as something that could be read at one sitting. While simple enough, the definition suggests a concern with concentrated form and unified artistic effect. In a sense, the short story has been around as long as people have been telling each other tales, to be sure, but as a literary form it came into its own in modern times, during the 19th century and it continues to be produced in considerable numbers. For many readers one of the great features is the one Poe pointed to: it is short. People who have never finished a novel by Henry James must be legion. So we can experience something with genuine literary merit, in an accessible form. Concentration, of course, can bring issues of comprehension and often short stories can seem puzzling or incomplete to the average reader. This class will attempt to develop our abilities to read with care and attention—and feeling—in order to make us better readers of any artistic text. The challenges of the short form turn out to be excellent opportunities for learning a lot, in a little space. We’ll make use of several inexpensive anthologies, and look at one or two central writers (Hemingway, for example) in more depth. The class will require the writing of a few short papers, engaging in online discussions on Blackboard, and three in class tests.
Prerequisite: 76-101.

76-294 Interpretive Practices
Fall: 9 units
This course introduces and explores some important theories and interpretive strategies for understanding literary or visual texts, including psychoanalysis, fiction, drama, and pictures. We will read essays on terms like "ideology," "intention," "dialogism," "culture," "genre," "convention" and explore interpretive approaches based on different kinds of critical theory, including cultural poetics, semiotics, Marxism, feminism, poststructuralism, and others. Literary authors to be studied include Herman Melville, Samuel Coleridge, Tom Stoppard, Thomas Pynchon, and others. Students are expected to contribute to class discussions. Three papers and a number of shorter assignments will be required.
Prerequisite: 76-101.

76-300 Professional Seminar
Fall: 3 units
This weekly, 3-unit seminar is designed to give professional writing majors an overview of possible career and internship options and ways to pursue their professional interests. Each session will feature guest presenters who are professionals working in diverse communications-related fields such as television, journalism, public relations, corporate and media relations, technical writing, medical communications, and working for non-profits. The visiting professionals talk about their own and related careers, show samples of their work, and answer student questions. The course is required for first-year MAPW students and is open to any public writing student who is urged to participate in their sophomore or junior years to explore options for internships and careers.

76-301 Internship
All Semesters
This course is designed to help you explore possible writing-related careers as you gain workplace experience and earn academic credit. You’ll work on- or off-campus as an entry-level professional for 8-10 hours per week in a field of interest to you. You might, for example, intern with a local newspaper or magazine or radio or TV station, work for a publisher or political campaign, or do research and promotions for a non-profit agency associated with a cause you feel strongly about. Other possibilities include local hospitals, museums, theatre and other arts groups, software documentation firms and other groups needing technical writers and communications specialists, PR and ad agencies, law-related sites, and just about any place you can think of that requires writing and communication skills. Most of your class time for the course will be completed through work at your internship site – a minimum of 120 hours (8-10 per week) over the semester for 9 units of credit. As the academic component of the course, you’ll keep a reflective journal and meet periodically with the internship coordinator to discuss your internship and related professional issues. You will be responsible for finding your own internship, but it is recommended that you set up a meeting with the instructor to talk about your interests and what opportunities are open to you. You should do this before registration week.

76-302 Global Communication Center Tutoring Practicum
Fall: 9 units
TBA
Prerequisite: 76-101.

76-306 Editing and Publishing
Fall and Spring
Note: Registration in this course is by permission only. Students must contact Prof. Costanzo directly. In this course students will work closely with the editors of Carnegie Mellon University Press to learn many of the facets of producing books. These range from business management and marketing to the elements of editing, book design, and production.

76-311 18th Century Literary and Cultural Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2010: Writing in 1542 Bartolome de las Casas "observed that not a few of the people involved in this story had become so anaesthetized to human suffering by their own greed and ambition that they ceased to be men" and in 1712 Alme Cesaire notes that "colonization, dehumanizes even the most civilized man." Writing 400 years apart both men reflect an anxiety towards the social and economic effects of imperial expansion, which stands in sharp contrast to the pro-expansionist attitude of many including government officials and merchants. The aim of this course is to explore the competing understandings of Britain as a nation and an empire, which were expressed throughout the eighteenth and early nineteenth century. We will examine the influence of the British imperialism in the works of authors as diverse as Daniel Defoe, Jonathan Swift, Olaudah Equiano, Jane Austen, and William Makepeace Thackeray. In addition, we will explore theories of nationhood by Srinivas Aravamudan, Michael Hardt, Antonio Negri, and Edward Said.
Prerequisite: 76-101.

76-313 19th Century Literature
Intermittent: 9 units
Topics vary by semester. Spring 2012: This course approaches nineteenth-century British literature by way of three controversial topics—evolution, capitalism, and culture—and their advocates or critics. Readings in Charles Darwin, Karl Marx, and Matthew Arnold on evolutionary sciences, wage labor and capital, and the arts of culture. Additional readings include the prose and poetry of Oscar Wilde (on art and socialism), William Morris (on utopia and design), H. G. Wells (science fiction), Christine Rossetti (on sexuality and the market), Charles Dickens and other writers who will show us the connections between class warfare, sciences of nature, and the arts.
Prerequisite: 76-101.
76-314 19th Century British Literary and Cultural Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2011: Changes in industry and education in the Victorian period affected women deeply; many women began to actively explore their options outside of the domestic arena, seeking access to education, careers, contraception, voting and alternatives to marriage and motherhood. These early feminists became known as “New Women,” and from around 1870 to 1900, discourse by and about them flourished. The New Woman both exhilarated and terrified. Was she a signifier of England’s progressive health or was she a monstrous harbinger of the decline of proper English society? How did she both redefine and entrench gender ideology in the late-nineteenth century? We will read short stories, journalistic articles and several novels that address the New Woman, including Sarah Grand’s The Heavenly Twins, Grant Allen’s The Typewritter Girl and Bram Stoker’s Dracula. Cultural narratives about gender, sexuality, science, industry and empire will inform our discussions.
Prerequisite: 76-101.

76-317 The History of the Novel
Intermittent: 9 units
This course will survey the English and American novel from the 18th century to the present. We will look at texts such as Henry Fielding’s Joseph Andrews, Jane Austen’s Pride and Prejudice or Emma, Charles Dickens’ Great Expectations, Frank Norris’ Octopus, James Joyce’s Dubliners, Virginia Woolf’s Mrs. Dalloway, and others. We will also read critical texts explaining the rise of the novel and assessing the place of fiction in modern life.
Prerequisite: 76-101.

76-318 Communicating in the Global Marketplace
Intermittent: 9 units
In this day and age, some of the most exciting employment opportunities are with multinational and international corporations and non-profits. But are you prepared for the challenge of working with professionals from all over the world? Even as more people around the globe learn English, specific cultural values, beliefs, and assumptions continue to influence the way in which they communicate. Often, behind a foreign accent, we encounter an entirely different worldview. The same word or phrase in English might actually carry very distinct connotations for someone whose native language is French, German, Russian, or Japanese. Can we learn to anticipate, understand, and become sensitive to these connotations? How can we mend potential miscommunications that might arise due to these conceptual differences? This course is designed as an introduction to international professional communication. We will talk about the way in which culture influences communication, about the job of translators and interpreters, and about specific communicative norms for the global marketplace. We will look at many concrete example of communication in the international arena, acting as problem-solvers and communication consultants who are focused on understanding and designing plans of action for navigating communicative obstacles. We will also have the opportunity to speak with professionals who are experienced in the field, and we will cover case studies ranging from corporate business to global activism and advocacy. The requirements for this course include a take-home exam, a short paper, and a final project.
Prerequisites: 76-270 or 76-271 or 76-272.

76-319 Environmental Rhetoric
Fall: 9 units
How people think and talk about the environment matters; it reveals what they value and shapes what they do. We will look at how competing discourses define man’s relationship to the natural world, frame environmental problems, and argue for public action. As we compare the environmental rhetoric of naturalists, scientists, policy makers, and activists, we will trace an American history that has managed to combine mystical celebration with militant critique, and scientific research with public debate. Equally important, this course will prepare you to act as a rhetorical consultant and writer, studying how writers communicate the three “Rs” of environmental rhetoric: relationship with nature, the presence of risk, and the need for response.
Prerequisite: 76-101.

76-321 Genre Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2011: Poe defined the short story as something that could be read at one sitting. While simple enough, the definition suggests a concern with concentrated form and unified artistic effect. In a sense, the short story has been around as long as people have been telling each other tales, to be sure, but as a literary form it came into its own in modern times, during the 19th century and it continues to be produced in considerable numbers. For many readers one of the great features is the one Poe pointed to: it is short. People who have never finished a novel by Henry James must be legion. So we can experience something with genuine literary merit, in an accessible form. Concentration, of course, can bring issues of comprehension and often short stories can seem puzzling or incomplete to the average reader. This class will attempt to develop our abilities to read with care and attention—and feeling—in order to make us better readers of any artistic text. The challenges of the short form turn out to be excellent opportunities for learning a lot, in a little space. We’ll make use of several inexpensive anthologies, and look at one or two central writers (Hemingway, for example) in more depth. The class will require the writing of a few short papers, engaging in online discussions on Blackboard, and three in class tests.
Prerequisite: 76-101.

76-322 Global Masala: South Asians in the Diaspora
Intermittent: 9 units
This course looks at the writings and experiences of South Asians (people from the Indian subcontinent and its environs) living in such places as the United States, Britain, and the Caribbean. During the semester, we will read literary works alongside histories of South Asian immigrants and theoretical works about diaspora. In the process, we will consider such themes as identity, immigration, race, class and globalization. We will examine the histories of migration and study how the experience of living between two homelands has been theorized. In addition to examining diasporic literature, the course will investigate present day South Asian global cultures including popular culture, film, music, and dance. Possible readings include works by V.S. Naipaul, Hanif Kureishi, Meera Syal, Salman Rushdie, Jhumpa Lahiri, Nadeem Aslam, Mohsin Hamid, and Michael Ondaatje.
Prerequisite: 76-101.

76-324 Topics in Rhetoric
Intermittent: 9 units
In this course, we will study communication strategies of effective leaders — people who seek to promote change in various professional, political, or cultural contexts. The main goals of the course are to understand rhetorical challenges that leaders face in different fields, to examine the language they use, and to learn (through theory, analysis, and practice) the most effective rhetorical strategies that can empower a leader. By drawing on the literature from management, organizational communication, psychology, and rhetoric, we will address a set of questions that include: (1) What makes an effective leader? (2) How do leaders use language and for what purposes? (3) What rhetorical strategies can be most useful to leaders to achieve their goals? (4) What is the role of creativity in leadership, and especially in the leader’s use of language? We will mine the literature on leadership for theoretical insights on rhetoric. Students will be expected to lead discussions on readings, a midterm that synthesizes the readings, and a final project that reviews the literature and provides an annotated bibliography in some subfield of rhetorical leadership.
76-325 Topics in Rhetoric
Intermittent: 9 units
Topics will vary by semester. Fall 2012: What do we mean when we say that someone has "twisted" our words, or that our words have been "taken out of context"? Why is Martin Luther King Jr. best remembered for saying, "I have a dream," and not for saying, "War is the greatest plague that can affect humanity?" What are political "talking points" and how are they perpetuated? How does a claim (un)founded or not become a fact? How does a fact become myth? These are just some of the questions that we will consider. More specifically, this is a course in how meaning changes as texts created in one context and for specific purposes are repeated, cited, and used in other contexts and for other purposes, sometimes related and relevant, sometimes not. More technically, we'll be focusing on the rhetorical nature of intertextual discourse. Our goal will be to examine the ways that people of all kinds—including politicians, journalists, and scientists—strategically draw upon and transform the statements, arguments, and evidence of other people to promote their own viewpoints or purposes. We will begin by investigating scholarship that views language as an extended conversation in which people struggle to have their own voices heard, and other voices countered or even suppressed. Later, we will survey a number of studies that suggest how individuals and organizations recontextualize and reinterpret prior discourse for persuasive ends. More specifically, we will analyze how the micro-features of the language (for example, qualifications, evaluations, and attributions) are used to persuade audiences that certain assertions are (not) factual, that certain speakers are (not) authoritative, and that certain proposed actions are (un)desirable. Ultimately, you will conduct your own research on intertextual rhetoric on a topic of specific interest to you.
Prerequisite: 76-101.

76-327 Special Topics in Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Fall 2012: This course surveys twentieth-century poetry of the Americas. As such, it brings together poets who are usually studied independently of each other due to boundaries of nation and language. During a 500-year history of forced migration and territorial conquest, the Americas, as a space for comparative poetics, enables alternative trajectories of modernity to emerge. Some of the questions we will consider include: What happens when we shift from a transatlantic focus on Anglo-American modernism to a hemispheric focus on the poetry of the Americas? What new concerns of major American modernist poets—such as T.S. Eliot, Hilda Doolittle, and William Carlos Williams—surface when we read them alongside their Latin American contemporaries—such as Ruben Dario, Delmira Augustina, and Xul Solar—instead of their usual British counterparts? What role does poetry of the African diaspora play in a hemispheric poetry? Does a shared politics of form come into relief, for example, when we pair the Harlem Renaissance blues lyrics of Langston Hughes with the Cuban verse of his friend Federico Garcia Lorca? What new discoveries might we make reading English-language feminist poets Adrienne Rich and Audre Lorde next to their Spanish-language peers Soledad Farina and Daisya Zamora (both of whom were forced into exile by state violence)? Throughout the semester, we will ask what new possibilities arise (as well as what limits) when we read poetry across linguistic and national lines. Our goal is to locate overlooked correspondences, as well as to identify problems of translation (broadly conceived to include not only issues to language, but historical and social impasse as well). (See Department for full description.)
Prerequisite: 76-101.

76-330 Medieval Literature
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. EXAMPLE: Fall 2011: Renaissance scholars sometimes promote the misconception that Shakespeare was the first writer to create characters with inner lives (rather than just social roles), that he was the inventor of the human, as Harold Bloom puts it. The varieties of writing—from the 700s to the 1400s—we will explore in this course will... (The course will include) Shakespeare's 1546 sonnet sequence, Venus and Adonis, Othello, The Winter's Tale, The Merchant of Venice, The Tempest, King Lear, Richard III, and the plays from the last time in the US that Americans suffered under the kind of gap that this course studies.

76-331 Renaissance Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Consult the Course Descriptions provided by the Department each semester for current offerings. EXAMPLE: X-Files of the Seventeenth Century. Ghosts, monsters, apologies, demons, and other strange phenomena: many of these so called "preternatural" occurrences were becoming the object of overlapping (and sometimes conflicting) forms of explanation during the seventeenth century. Whereas some of these phenomena could be explored philosophically—with reference to natural causes—others belonged to religious debate or seemed exclusively to exist in the imagination. Using a broad range of texts, we will examine the widespread interest in the preternatural in seventeenth century culture, exploring the political, religious, and ideological consequences of this fascination. Texts for the class will include images of natural "marvels" and "monstrosities," collections of "curiosities," plays by William Shakespeare and Ben Jonson, utopian fiction by Margaret Cavendish, selections from Edmund Spenser's Faerie Queene, seventeenth century crime pamphlets, philosophical texts by Francis Bacon, Robert Hooke's images from the microscope, readings in Renaissance and classical poetics, and various religious texts. Students can expect the reading for this class to be demanding but interesting. Several written assignments, a final exam, and conscientious participation in class discussion will be required.

76-332 African American Literature
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. Spring 2011: This course will introduce you to diverse examples of African-Amer.

76-333 19th Century Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. EXAMPLE Spring 2012: It started with a financial panic that closed the New York Stock Exchange for ten days. One quarter of the nation's transportation companies went bankrupt, as did nearly 20,000 businesses. Unemployment reached 14%. Four years later it was officially declared a "depression." When did all of this happen? Was it 2009? Or the 1930s? No, it was the depression triggered by the financial panic of 1873. Out of this period, also known as the "Gilded Age," came a unique strain of American literature. Frank Norris's grisly tale of an overbearing dentist and his miscreant wife, McTeague, Andrew Carnegie's autobiography, Upton Sinclair's Townsend fiction, The Jungle, and Booth Tarkington's tragic love story House of Mirth, Charlotte Perkins Gilman's feminist utopian novel, Herland, William Dean Howells's Capitalist satire, The Rise of Silas Lapham, Theodor Drieser's mournful Sister Carrie—all of these writings react to, and try to shape, the economic scene of a century ago. These novels, which were often critical of corporate capitalism, gave us a rich and detailed picture of the last time in the US that Americans suffered under the kind of gap we have today between rich and poor. In the US today the top 1% controls 42% of the country's wealth, while the bottom 60% controls a mere 7% of the country's wealth. What can we learn about the present by reading the fictions of financial crisis and inequality in the past?
Prerequisite: 76-101.
76-335 20th Century Literary and Cultural Studies: Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Spring 2012: This course will survey American fiction from 1945 to 1980. “Post-1945” has typically been the catch-all to describe American literature after the modernist period, and has often been called “contemporary.” However, that designation now seems inadequate: writers who became prominent in the immediate postwar era are historically removed, and writers arising since 1980 form a distinctly different generation, with a different sensibility. This course will account for the immediate postwar period, with the working hypothesis that we need to create a new construction of American literature and its recent past. It will look at authors like Norman Mailer, Flannery O’Connor, Saul Bellow, John Updike, and Thomas Pynchon. Prerequisite: 76-101.

76-337 Global Literature: Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: This course examines literary work that represents the experiences of globalization with a specific focus on works from the South Asian subcontinent. Reading novels, short stories and literary essays, we will explore works that represent the economic, political and social transformations brought by global flows of people, information and commodities. We will also consider how literature as a cultural and aesthetic phenomenon reflects and participates in these processes of globalization. Looking at both postcolonial literature and works from the diaspora, we will consider interconnections between South Asia— especially India, Pakistan, and Bangladesh—and the West. Possible titles include Aravind Adiga’s “The White Tiger,” Pankaj Mishra’s “The Temptations of the West,” Herman Melville’s “Moby Dick,” and Jhumpa Lahiri’s “Unaccustomed Earth.” Prerequisite: 76-101.

76-338 Media and Film Studies: Intermittent: 9 units
Topics will vary by semester. Fall 2012: New media isn’t new; old media isn’t dead. The term “new media” itself presumes that a wholly original technology replaces another outdated one. This course will trace a history of media change from 1844 to the present day, and, roughly from the telegraph to the iPad, though we will dedicate much of our attention to the mid to late twentieth century. Rather than accept a straightforward linear narrative of innovation, we will, instead, privilege use, reception, and context. The class will also explore various “dead media,” technologies that got left behind in the march of progress towards the digital. By approaching the very idea of new media critically, the class intends to deepen students’ understanding of both the historical and contemporary position of the digital media we rely upon to interact with the world around us. While the course readings will be comprised primarily of theoretical and historical approaches to media, we will also draw upon many primary sources such as science-fiction, comics, and popular literature. Students will also be expected to develop methods to deal with the specifics of each medium. Students will keep media journals chronicling their interaction with various forms of media - new and old - and experiment with a small sample of digital archives and digital production software in order to complete a case study midterm project on an overlooked medium (or aspect of a medium) of their choice. Prerequisite: 76-101.

76-339 Advanced Film and Media Studies: Intermittent: 9 units
Topics will vary by semester. Summer 2012: The films in this course were made from the 1940s to the 2000s—all in some way explore the interrelations of crime, mystery, and gender as they index some key changes in American culture of the times. Some are classics in this category—Double Indemnity, Sunset Boulevard, or Chinatown. Others have been regarded as “minor” but exceptional films with growing reputations—Gun Crazy, Kiss Me Deadly, Touch of Evil. These are more recent and introduce different dimensions into this tradition of American film. Themes this semester: „film noir“ (those of 1944-56); others expand the styles and obsessions of noir into far broader scenarios of American cultural exploration. Several films use the genre of mystery to explore mental or sexual pathology or dream-like obsessive states. The course will show how American film links the most private matters of psyche and sexuality to public arenas of power, crime, class, and culture. No papers will be required, and full class-participation. Prerequisite: 76-239.

76-340 Topics in Rhetoric: Intermittent: 9 units
Ever since the development of radio in the early 20th century, Americans have expected that we would soon all talk alike. The conviction that the media would make us all sound the same revived with the widespread adoption of television, starting in the 1940s, and the development of the internet in the 1990s led to worry about how soon we’d all be writing the same. But fears of the homogenizing effects of the mass media on American English have proven to be exaggerated. Americans still talk and write in many different won. In this course we explore why this should be. Why don’t we all speak alike? Why do we need variation in language? We will explore how regional and social dialects and varieties come to be and what their functions are, and you will learn how to hear, see, and describe varieties of language. We will also touch on American languages other than English. Documentary films and online materials about language will be the basis for another strand of the course, as we work together to explore how linguistic variety can best be represented and explained in non-technical ways, and in a variety of media, for the general public. Reading will be mainly in two books: American English, by Walt Wolfram and Natalie Schilling-Estes (2nd. edition), and Language in the USA: Themes for the Twenty-First Century, edited by Edward Finegan and John R. Rickford. There will be regular homework assignments, a midterm exam, and a final project. Prerequisite: 76-101.

76-341 Advanced Gender Studies: Intermittent: 9 units
Topics vary by semester. Consult the department for current course offerings. Example, Fall 2010: This course starts with gender as a category of analysis: how does gender work as a principle of difference or sameness? How does it organize identity—or disrupt it? How does it reinforce or destabilize our understandings of identity as organized around “masculine” and “feminine”? Readings will be drawn from canonical feminist theories of gender, from Gayle Rubin’s classic “Traffic in Women” and Donna Haraway’s work on “Cyborg Feminism” to more recent contributions to gender theory from transgender scholars and activists. To ground our theoretical work, groups of students in the class will, with the help of the instructor, identify four to five historically and culturally specific case studies which will serve as both objects of analysis and additional sources of theory. The majority of the readings for our class will be derived from these case studies, allowing for students’ input into the choice of course materials. Students can expect to expand their knowledge of gender theory and to explore those theoretical concepts through objects of study of particular relevance to their own intellectual interests. Prerequisite: 76-101.

76-344 Studies in Print Culture: Intermittent: 9 units
Topics will vary by semester. Fall 2012: Censorship? Banned books? Book burnings? Could it happen here? In 20th-century America some of the most important films and books were banned, censored, produced in other countries, or written under an alias. But artists don’t like to be silenced, and have found ways to tell their stories, regardless of the consequences. In this course we will examine three kinds of censorship: political censorship, racial censorship, and censorship based on sex/sexuality. We will read texts such as Kate Chopin’s The Awakening, John Steinbeck’s The Grapes of Wrath (and film), J.D. Salinger’s The Catcher in the Rye, Harper Lee’s To Kill a Mockingbird (and film), Kurt Vonnegut’s Slaughterhouse Five, Toni Morrison’s Beloved (and film), Richard Wright’s Native Son, and Truman Capote’s In Cold Blood (and film). We will also celebrate the American Library Association’s banned book week, which is September 30th to October 6th. Prerequisite: 76-101.
76-345 Renaissance Studies
Intermittent: 9 units
In the age of Shakespeare and Milton (the sixteenth and seventeenth centuries), poetry, international politics, and theology were far more intertwined than they are today. While dedicated primarily to poetry, this course will investigate the implications of this intertwining in practice. Seeking to do justice to the true interdisciplinarity of Renaissance poetry, the course supposes that poetry and verse technique mattered so much in the period due to questions spanning art, politics, and theology of how power (verbal power, divine power, political power) should be represented. Biographically, many canonical poets we’ll study in the course worked as ambassadors, representing power abroad (Wyatt, Sidney, Donne, Marvell). Many more poets including Shakespeare and Milton thematized diplomacy, in both its divine and more worldly forms (“angel,” in fact, means “messenger”). Poetry too was seen in similar terms. As Coleridge would later write, poems were “the envos or representatives of vital passion.” Readings include Shakespeare’s Hamlet, Milton’s Paradise Lost, and John Donne’s “The Ecstasy.” The class will be introduced and contextualized through writers such as Pseudo-Dionysius, John Calvin, Thomas Hobbes, Alberico Gentili, and George Puttenham. Topics to be considered will include historical poetics, divinity, sovereignty, immunity, license, fidelity, craft, and accommodation. Assignments and class discussions will be occasions to practice historically-informed criticism; to compare conceptual structures within seemingly distinct domains of history and thought; and to articulate major fissures and changes in Renaissance angelology, diplomatic practice, and literary craft. Prerequisite: 76-101.

76-346 Renaissance Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: The starting point for this course is a question at the nexus of theology, politics, and art that no less central to the age of Shakespeare and Milton than it is today: how should power be represented? Biographically, many canonical poets of the sixteenth and seventeenth centuries worked as ambassadors, representing power abroad (Wyatt, Sidney, Donne, Marvell). Many more poets including Shakespeare and Milton thematized diplomacy, in both its divine and more worldly forms. What, then, can structures of mediation like diplomacy and angelic intervention tell us about works like Sidney’s sonnet sequence Astrophil and Stella, Shakespeare’s Hamlet, or Milton’s Paradise Lost? And what can Renaissance poetry tell us about topics such as sovereignty, immunity, license, fidelity, automation, and accommodation? The course will include introductory and contextual readings from Genesis, Pseudo-Dionysius, John Calvin, Thomas Hobbes, Alberico Gentili, and George Puttenham. Assignments and class discussions will be occasions to practice historically-informed criticism; to compare conceptual structures within seemingly distinct domains of history and thought; and to articulate major fissures and changes in Renaissance angelology, diplomatic practice, and literary craft. Prerequisite: 76-101.

76-347 American Literary and Cultural Studies: Contemporary Fiction
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the Department each semester for current offerings. Example, Fall 2011: This course will survey recent American fiction, roughly from 1980 to the present. Many critics have defined the previous era as “postmodern,” but no one quite knows what to call this contemporary period. What, then, are the roles and places of women in these new networks and activities? What is the function of the text—fiction, memoir, scholarly article or film—in describing these roles and places? This course will begin exploring these questions historically by theorizing women’s relation to the nation in nationalist struggles. We will look specifically at the close connection between women and elements of tradition, including religion. Moving into the contemporary moment, we will examine the experiences of immigrant women and women in the global factory. As a way to interrogate our own assumptions, we will consider heated debates about global feminism. Throughout the course, we will think through the role of cultural representations in these issues. Readings will be drawn from around the world, and include theoretical works as well as literary and filmic representations. Prerequisite: 76-101.

76-348 Lost Generation
Intermittent: 9 units
Before the Beat Generation there was the Lost Generation. Both moments of literary history have an important relevance for our time, and both produced many major literary works. The 20s, like the 50s and 60s, were marked by the effects of World War. Gertrude Stein seems to have started the whole generation naming fad with her comment to Hemingway, “You are the lost generation.” Paul Fussell identifies the cultural effect of WWI as the production of ‘irony’ as the central quality of modern identity (Some Beat writers make a similar claim for the effects of WWII). This class is neither a prequel nor a sequel to the Beat writers class; it is related in theme but focused on different writers and texts. Students might consider taking this class as a point of entry to ‘The Beat,’ or might consider this class as a follow-on to ‘The Beat’ in order to understand more fully some of the central literary and historical issues of our time. In both cases we will focus on the intersection between cultural change and major war. The Lost Generation class might include, for example, work by Stein, Hemingway, W.B. Yeats, Ezra Pound, T.S. Eliot, the major War Poets, F. Scott Fitzgerald, Robert Graves, Vera Brittain, and Evelyn Waugh. Prerequisite: 76-101.

76-353 Global Studies
Intermittent: 9 units
Topics vary by semester. Fall 2012: This course looks at the relationship between women and globalization. Globalization has been defined as the “creation of new and the multiplication of existing social networks and activities that increasingly overcome traditional political, economic, cultural, and geographical boundaries.” What, then, are the roles and places of women in these new networks and activities? What is the function of the text—fiction, memoir, scholarly article or film—in describing these roles and places? This course will begin exploring these questions historically by theorizing women’s relation to the nation in nationalist struggles. We will look specifically at the close connection between women and elements of tradition, including religion. Moving into the contemporary moment, we will examine the experiences of immigrant women and women in the global factory. As a way to interrogate our own assumptions, we will consider heated debates about global feminism. Throughout the course, we will think through the role of cultural representations in these issues. Readings will be drawn from around the world, and include theoretical works as well as literary and filmic representations. Prerequisite: 76-101.

76-354 South Asian Literature
Intermittent: 9 units
Topics vary by semester. Please consult the English Department for the most current description. Example, Fall 2011: This course focuses on twentieth-century literature written in English from India, Pakistan and other parts of South Asia, as well as by people of South Asian origin. The course will begin by looking at literary representations that portray the struggle for decolonization and the trauma of partition. As we move forward to the contemporary period, we will examine the competing aesthetics of social and magical realism. We will then look back at India from the perspective of the diaspora, considering themes of identity, immigration and globalization from the perspective of South Asians writing in Britain and the United States. Texts might include works by Rabindranath Tagore, Saadat Hasan Manto, Mahasweta Devi, Salman Rushdie, Hanif Kureishi, Amitav Ghosh, Aravind Adiga, Romesh Gunesekera, Chitra Banerjee Divakaruni and Jhumpa Lahiri. Prerequisite: 76-101.
76-355 Leadership, Dialogue, and Change
Intermittent: 9 units
Leadership is often associated with the exercise of institutional authority or individual power. However the tradition of leadership based on dialogue shows us a powerful counter-rhetoric—one which organizes people to work together on complex problems through problem-posing, pragmatic inquiry, and the inclusion of marginalized perspectives. We will examine how this approach to leadership and change works in public voices of writers from Emerson and Martin Luther King, to the community organizing of an Alinsky, to the cultural critiques of African-American and feminist scholars such as Cornel West or bell hooks, and—equally importantly—in the ways ordinary professionals include voices and integrate social values into effective workplace writing, and the ways students call forth change on campuses. This introduction to the rhetoric of making a difference shows how its roots in American philosophical pragmatism created a focus on outcomes, not just ideals, and translated commitments into strategic rhetorical practices. In this course you will develop your own skills in writing and leadership by working as a “rhetorical consultant” to a campus or community group: learning how to investigate and define a shared problem, to develop a briefing book for deliberation, and to support inclusive decision making by documenting rival perspectives and options (see http://www.cmu.edu.thinktank). This portfolio project will also demonstrate your research skills and ability to support a problem-solving dialogue within an intercultural community or complex organization.
Prerequisite: 76-101.

76-359 Planning and Testing Documents
Intermittent: 9 units
We often send the documents we produce out into the world, having worked hard on them and hoping that they achieve the purposes that we intend for them. In some situations, this suffices. In others, however, we may need more than hard work and hope—we may need to know that a document is working: Are thousands or even millions of people going to be using the document? Can they comprehend it? Can they follow its directions safely? Are they fearful or confident as they do so? In Planning and Testing Documents, you will study and practice methods for providing valid and reliable answers to these types of questions, both in the lab—before a document goes out the door—and in the field—after a document is in the world. Learning about the problems readers have using documents can be a rewarding experience for professional writers. And the reasons for doing so are several: Various studies have shown that reader feedback helps professional writers optimize the effectiveness of their documents, that professional writers themselves are unable to predict the problems readers experience, and that writers become more aware of their audiences and improve as writers when they are regularly confronted with reader feedback. Topics will include both basic issues that pertain to all empirical research methods—sampling, response rates, validity and reliability, the design of questionnaires, scales and surveys, the ethical issues involved in doing research with people—as well as methods specifically relevant to planning and testing documents, such as subject matter expert (SME) observation and interviews, think-aloud usability testing (you’ll learn more than the “crash course” basics that you learned in your introductory professional writing course), plus-minus testing method, designing comprehension tests, and other reader-focused evaluation methods. (See Dept. for full description)
Prerequisites: 76-270 or 76-271 or 76-272 or 76-390.

76-360 Literary Journalism Workshop
Spring: 9 units
Literary Journalism is a form whose tradition dates back to Dickens. It takes as its subject “ordinary people,” and reveals lives fully, implicitly or explicitly making connections between the personal, political, and historical. The course will acquaint you with some classics of the form, along with contemporary work by writers who are writing this “literary” journalism using all the tools of the fiction writer. We will read books by writers who have spent considerable time in the field as researchers to bring us stories of so-called ordinary people who might serve to enlighten or reveal something about the world. Students will be asked to do field research throughout the term addition to their writing and reading assignments. All students will also produce an oral presentation of one of these assignments.
Prerequisites: 76-260 or 76-261 or 76-262 or 76-265 or 76-270 or 76-271 or 76-272 or 76-372 or 76-472.

76-361 The Film Festival: Faces of Democracy in Contemporary World Cinema
Intermittent: 9 units
Topics will vary by semester. Consult detailed course descriptions available from the Department each semester for details. Fall 2006: Students will take on the project of planning and managing a film festival that draws a college- and city-wide audience. The class members will collaborate on all aspects of the festival: selecting films, generating and distributing marketing materials, designing and scheduling events, arranging facilities and general logistics, coordinating internal and external public relations, organizing fundraisers, rallying the local communities—in short, all the aspects involved in making the event a spectacular/sensational success! The theme of 2006’s festival is Freedom and Democracy. In examining some of the world’s best feature films and documentaries on this theme, we shall emphasize countries in political transition: where the dilemmas of contemporary Democracy are most apparent, such as Israel, France, where the practice of Democracy is recent, such as Poland, Hungary, Czech Republic; where it is only now being introduced, such as Iraq, Afghanistan. A unique feature of this course-cum-festival will be several directors’ participation as guest speakers on the democratic - and other - issues informing their films. Since this is not a typical academic class, there will be neither final exams nor research papers. Instead, the instructor will base grading on short papers, commitment to the project, and class discussion. The best papers as intro to the films will be published in one of the city papers.

76-362 Reading in Forms: Nonfiction
Intermittent: 9 units
Here is a list of some of the books that have affected our civilization and which, as writers, we should read; even emulate. They are examples of important nonfiction. No particular order of reading them yet, but you have the summer to get acquainted: Silent Spring by Rachel Carson, The Rights of Man by Thomas Paine, Bury My Heart at Wounded Knee by Dee Alexander Brown, Speak Memory by Valdimir Nabokov, Goodbye to All That by Robert Graves, The Female Eunuch by Germaine Greer, A Room of One’s Own by Virginia Woolf, Slouching toward Bethlehem by Joan Didion, Innocents Abroad by Mark Twain, The Symposium by Plato, Notes of a Native Son by James Baldwin. There may be an addition or two. Each book will be “reviewed” by a short response paper no more than two pages. There will be a larger paper at mid term, and then a final paper to be discussed. Three unexcused absences are grounds for failure.
Prerequisite: 76-101.

76-363 Reading in Forms: Poetry
Intermittent: 9 units
This course will examine the role music plays as a theme and structural device in contemporary American poetry. The course will explore collections about musicians as well as collections written by musicians in genres that incude Blues, jazz, Rock and Hiphop. Since class will be structured primarily around presentations, considered discussions and poetic responses, students should already be familiar with the major principles of poetry and be able to utilize them accordingly.
Prerequisite: 76-101.

76-364 Readings in Forms: Fictions
Intermittent: 9 units
This is a reading intensive course in Contemporary World Literature (Indian, Irish, Asian, African, North and South American) with an emphasis on novels and short stories. In response to a wide variety of texts, students will write both critical papers, and creative prose pieces. Students will also be responsible for oral class presentations, and will complete a final project on a contemporary writer of their own choosing. The course aims to deepen and broaden the reading and writing experience of the developing creative writer.
Prerequisite: 76-101.

76-365 Beginning Poetry Workshop
Fall and Spring: 9 units
In this course, you will be expected to take your knowledge of the principles and elements of poetry learned in the Survey of Forms: Poetry course and utilize them in workshop discussions, written analysis, and the composition of your own poems. In addition, readings of books by other poets will be required, along with participation in a book-making project.
Prerequisite: 76-265.
76-367 Genre Studies
Intermittent: 9 units
Topics vary by semester. Fall 2012: The early part of the 20th century is often compared to the Renaissance as a time of massive literary innovation and production. This class will focus on a few novels by writers at the center of the invention of the modern literary world. Our goal will be to sharpen our reading skills and our understanding of a variety of experimental techniques in the novel. Henry James is often thought to be the source of modern ideas about fiction writing and was a powerful influence on all significant writers who followed him. D.H. Lawrence was a passionate critic of traditional novel forms, seeking a form more appropriate to the experiences of modern life. With his collaborator Ford Madox Ford, Joseph Conrad developed the technique known as impressionism, a style intended above all, as he said, to make us see. He is known for the complexity of his narratives and his formal experiments. James Joyce is regarded as having perfected all of the formal possibilities of the novel, effectively exhausting the form. The reading list will include books of this sort: Henry James: The Bostonians, Joseph Conrad: Lord Jim; D.H. Lawrence Lady Chatterley’s Lover, James Joyce: Ulysses, Virginia Woolf: To The Lighthouse (not the actual list, but like that).
Prerequisite: 76-101.

76-372 Topics in Journalism
Fall: 9 units
In this introductory class, taught by a working journalist, students will learn the fundamental skills of reporting, writing and copy editing. We’ll start with the basics – judging newsworthiness, conducting research and interviews, then organizing the information into a concise, clear, accurate and interesting news story. Because the key to learning to write effectively is to practice the necessary skills, class emphasis – and much of your grade – will be based on seven writing assignments involving current events and covering various types of news writing. Through readings, assignments and class discussion, we’ll tackle questions such as: What makes a story newsworthy? How does a reporter decide which points to emphasize? What are effective techniques for a successful interview? How does a journalist turn pages of scribbled notes into a coherent news story? We’ll do a lot of writing, but we’ll also examine issues and trends affecting journalism today. We’ll cover at least two live events and hear from local professionals about working in print, broadcast and public relations. We’ll also look at how newer mediums – such as blogs, the internet, and cable news – shape and influence news reporting.
Prerequisite: 76-101.

76-373 Topics in Rhetoric: Argument
Fall and Spring: 9 units
This course is an introduction to the theory and practice of argument. The session begins with an overview of major theories of (and approaches to) argument, along with short assignments to critically assess their value and relevance to the types of argument about which you, the student, are encouraged to investigate. You will choose a type or genre of argument upon which to focus your research. The argument type can be academic, practical, professional, and so forth, so long as it is understandable using terms and concepts covered by the course. During the second part of the session we will refine our understanding of argument, and you will develop your own approach to argument analysis. The last third of the session will be devoted to producing an original argument of the type you are researching.
Prerequisite: 76-101.

76-375 Magazine Writing
Fall: 9 units
In this course we’ll be reading lots of great nonfiction, some of which has appeared in magazines during the past few years. We’ll look at how excellent nonfiction for magazines has to employ a strong narrative voice, and the techniques of storytelling. Students will be asked to research and write their own articles, based on a variety of assignments. The class will be conducted as a discussion, and demands participation from each class member.
Prerequisites: 76-260 or 76-262 or 76-270 or 76-271 or 76-272 or 76-372.

76-377 Rhetoric of Fiction
Intermittent: 9 units
Wayne Booth’s book, The Rhetoric of Fiction, is one of the classic discussions of the ways in which fiction communicates, moves, or motivates us. It is a commonplace to assume that literature has a message, but it is still not at all clear just how an imaginative representation of the world does, or can, communicate. Booth had particular difficulty understanding how fiction could communicate a felt sense of life and value when there was doubt about narrative authority, or the ‘reliability’ of the author. So, postmodern fiction (from Joyce on) caused him problems. In an attempt to develop a postmodern rhetoric of fiction we shall be looking at texts that deal directly with issues of persuasion, or texts that seem directly to address the reader. Of particular interest will be texts that indirectly implicate the reader, and achieve a kind of implicit rhetoric even when they apparently frustrate normal expectations of communicative language (e.g. the apparent fact that the reader is also a character in Calvino’s ‘novel’ if on a winters’ night’). We’ll consider the kinds of problems (and solutions to those problems) caused by excessive irony, by ‘showing’ rather than ‘telling’ and by the ‘absent author;’ in texts like Madame Bovary, Notes From Underground, Portrait of the Artist as a Young Man, etc.
Prerequisite: 76-101.

76-378 Literacy: Educational Theory and Community Practice
Intermittent: 9 units
Literacy has been called the engine of economic development, the road to social advancement, and the prerequisite for critical abstract thought. But is it? And what should count as literacy: using the discourse of an educated elite or laying down a rap? Competing theories of what counts as “literacy”—and how to teach it—shape educational policy and workplace training. However, they may ignore some remarkable ways literacy is also used by people in non-elite communities to speak and act for themselves. In this introduction to the interdisciplinary study of literacy—its history, theory, and problems—we will first explore competing theories of what literacy allows you to do, how people learn to carry off different literate practices, and what schools should teach. Then we will turn ideas into action in a hands-on, community literacy project, helping urban students use writing to take literate action for themselves. As mentors, we meet on campus for 8 weeks with teenagers from Pittsburgh’s inner city neighborhoods who are working on the challenging transition from school to work. They earn the opportunity to come to CMU as part of Start On Success (SOS), an innovative internship that helps urban teenagers with hidden learning disabilities negotiate the new demands of work or college. We mentor them through Decision Makers (a CMU computer-supported learning project that uses writing as a tool for reflective decision making.) As your S.O.S Scholar creates a personal Decision Maker’s journey Book and learns new strategies for writing, planning and decision making, you will see literacy in action and develop your own skills in intercultural collaboration and inquiry. (See Department for full description.)
Prerequisite: 76-101.

76-385 Introduction to Discourse Analysis
Fall: 9 units
Discourse analysis places a primary focus on how things are said; and this close attention to the details of “language in use” can offer insight into a variety of questions posed by researchers across the humanities and social sciences. In this course, we will examine the way discourse is itself a form of social action that plays a fundamental role in organizing social, cultural, and political life. In addition to becoming familiar with a variety of approaches and topics in the study of discourse, a major aim of the course is for you to develop the tools and skills needed to analyze actual discourse data. This will involve learning how to read transcripts and transcribe data at different levels of detail, learning how to ask questions about the data based on different analytic interests, and developing a vocabulary of scholarly terms and concepts that will allow you to comment on discourse features as you formulate interesting and persuasive claims. The first part of the course will involve assignments with shared data to develop fundamental skills. In addition, seminar participants will be responsible for selecting pieces of discourse for mini data sessions throughout the semester. For the final assignment, you will choose and analyze a piece of spoken or written discourse of interest to you. In the end, you should come away from the course with an ability to think critically about the way discourse operates in the world.
Prerequisite: 76-101.
76-386 Language & Culture
Intermittent: 9 units
In this course, we will take an ethnographic approach to examine language as a form of action through which social, cultural and political relations are constituted. Topics will explore language as it intersects with thought, ideology, identity, race and racism, ethnicity, gender, power, and linguistic diversity. In addition to articles, we will read several full-length ethnographies that focus on language practices within particular communities. The goals of the course are to (1) provide an introduction to key ideas in the study of language and culture, including the concepts of ideology, dialogism, identity, and indexicality; (2) equip students with a critical awareness of the role language plays in social, cultural and political interaction across a variety of cultures; and (3) explore the potential of ethnography for informing analyses of language and discourse.
Prerequisite: 76-101.

76-387 Narrative & Argument
Intermittent: 9 units
This course investigates information effects basic to the communication professional, generated primarily through structures of narrative and argument. We cover various genres supported by these structures, such as personal narratives, profiles, scenic writing, oral histories, information and instruction writing and policy argument. This course emphasizes both the production and the analysis of writing.
Prerequisite: 76-101.

76-389 Rhetorical Grammar
Spring: 9 units
This is a course in the grammar that characterizes relatively formal, relatively planned, often written English. As we develop and/or review a vocabulary for talking about the structural choices that are available to writers of English, we will practice analyzing and constructing sentences and parts of sentences. The course is meant primarily for people whose professional plans include writing or editing. Grades are based on 5 quizzes, midterm and final exams, homework assignments, and class attendance and preparation. Textbook: Hopper, Paul J. 1999. A Short Course in Grammar. Norton.
Prerequisite: 76-101.

76-390 Style
Fall and Spring: 9 units
In classical rhetoric, “style” is a term that refers not to what we write but how we write. Yet considerations about how we write - coherence, emphasis, concession, shape, diction, and elegance - can never be fully separated from an understanding of what, why, and for whom we are writing. Ideally, then, far from being an exercise in expressing personal idiosyncrasies, revising style means understanding a set of strategic choices and always weighing these choices in relation to questions such as, “Who is my audience?” and “What is my purpose?” This course will have two main objectives: (1) to help you develop a repertoire of stylistic options and a critical vocabulary for discussing those options, and (2) to give you the opportunity to put this knowledge into practice when revising your own writing and the writing of others. Two recurring questions for us will be the following: if style depends on both the rhetorical situation of a text and knowledge of specific guidelines, how can we ever say that we have achieved “good” style? Should stylistic rules or practical experience carry more weight in the decisions we make as writers?
Prerequisite: 76-101.

76-391 Document Design
Fall: 12 units
Today, many professionals are responsible for the visual design of documents. This course provides students who have already learned the foundation of written communication with an opportunity to develop the ability to analyze and create visual-verbal synergy in printed documents. Students will be introduced to the basic concepts and vocabulary, as well as the practical issues of visual communication design through a series of hands-on projects in various rhetorical situations. Assigned readings will complement the projects in exploring document design from historical, theoretical, and technological perspectives. Class discussions and critiquing are an essential part of this course. Adobe Creative Studio (InDesign, Photoshop, Illustrator) will be taught in class, and used to create the assigned projects.
Prerequisites: 76-270 or 76-271.

76-393 Rhetorical Traditions
Intermittent: 9 units
Rhetoric has traditionally been the study of the relationship between words and action, with persuasion as its central concern. As one of the oldest academic disciplines in the West, rhetoric has provided concepts, models, and systems for understanding how we use words to do things. In this course, we will examine various approaches to rhetoric in light of recurring questions about its definition, legitimacy, function, and methods. Specifically, we will be interested in some of the following questions: How does persuasive communication take place? How is persuasive communication influenced by various cultural, social, and political phenomena? How can we apply rhetorical concepts to current social and political problems? We will also be interested in how these questions relate to particular examples of rhetorical practice, such as Gorgias’s Encomium of Helen, Thoreau’s Civil Disobedience, and more recently, Michael Moore’s film, FAKRENHEIT 9/11. Assignments will include a take-home midterm and final, as well as a final paper.

76-394 Research in English
Fall: 9 units
Advising Note: 76-394 is offered in the fall only. EBA majors should take 76-394 in the fall of their junior year to prepare for EBA 400-level seminar courses, for which 76-394 is a prerequisite. This course offers training in gathering information systematically and building arguments based on that information. Students will hone their skills in choosing a topic, addressing it with the help of relevant research resources, reading and interpreting texts, doing critical commentary, and ethnographic fieldwork techniques such as observation and interview. Students will also learn how to situate their work in the context of research in the field, by testing their hypotheses against alternatives and presenting their research to audiences in English studies. Course content and student research will be organized around a genealogical approach to two of Shakespeare’s plays, Othello and The Merchant of Venice. We will investigate how performances of these two texts signify race, class, and gender, and other cultural differences in the very recent past and in the early period of British Shakespearian adaptation, 1660-1760. Although we will read scholarly editions of Othello and The Merchant of Venice, our research will focus on the cultural contexts for these two plays have been performed and interpreted, rather than on the original play texts or on Shakespeare as an author. (See dept. for full description)
Prerequisite: 76-294.

76-395 Science Writing
Spring: 9 units
This course will teach students how to write clear, well-organized, compelling articles about science, technology and health topics for a general audience. Students will learn how to conduct research on scientific topics using primary and secondary sources, how to conduct interviews, and how to organize that information in a logical fashion for presentation. For writing majors, the course will increase their understanding of scientific research and how to describe it accurately and completely to a general audience. For science majors, this course will teach them how to craft fluid, powerful prose so that they can bring their disciplines to life. The course is not intended just for those who want to become science journalists, but for anyone who may have the need to explain technical information to a general audience, whether it is an engineer describing a green building project at a public hearing, a doctor describing the latest research on a disease to a patient advocacy group, or a computer programmer describing new software to his firm's marketing staff. Students will get a chance to read several examples of top-notch science writing and interview researchers, but the primary emphasis will be on writing a series of articles — and rewriting them after they’ve been edited. The articles will range from profiles of scientists to explanations of how something works to explorations of controversies in science. Students should expect to see their writing critiqued in class from time to time, in a process similar to what journalists routinely go through. The goal will be clarity and verve; the ethos will be mutual learning and enjoyment.
Prerequisites: 76-270 or 76-271 or 76-272 or 76-372 or 76-375 or 76-472.
67-396 Non-Profit Advocacy: Genres, Methods, and Issues  
**Intermittent: 9 units**  
Given the changes brought on by the information age, non-profit organizations, like all organizations, face an increasing diversity of audiences and media choices. What hasn’t changed is the need for effective arguments (print and digital) that respond to both the situations at hand and their organizational contexts. In this course, designed for students pursuing careers in professional communication, we’ll examine the critically important practices of argument and advocacy. While our central focus will be on non-profits—the arts, education, political advocacy and social causes—the techniques we’ll learn are also broadly applicable to communications careers in all sectors. Our main focus will be on how arguments and media choices respond to communication philosophies, to specific organizational goals and, of course, to rhetorical situations. Among other questions, we will ask, how does speaking in the “voice” of an organization change the way we communicate? How can we adapt the genres of organizational communication to meet our organization’s goals? How can we have impact while working with limited budgets? The final project will be an interconnected set of portfolio pieces that demonstrates both relevant skills and a high-level theoretical understanding of what makes a public argument successful. Students will also gain experience in translating their technical expertise into language that potential employers understand and look for.  
Prerequisites: 76-270 or 76-271 or 76-272 or 76-372 or 76-373.

67-397 Instructional Text Design  
**Intermittent: 9 units**  
This course focuses on the planning, writing, and evaluating of instruction of various kinds, especially instructional texts. It is particularly appropriate for professional and technical writers, but also a good option for anyone interested in fields that involve substantial instruction, such as teaching or employee training. In the first part of the course, we’ll examine the recent history of instructional design and the major current theories. Then we’ll take a step back and study the concepts of learning upon which these theories are based, with particular attention to their implications for how instruction is structured. You’ll find that different learners (e.g., children, older adults) and goals (e.g., learning concepts and principles, learning to apply principles to solve novel problems, learning a procedure, learning to change one’s behavior, etc.) require different types of instruction. In the second part of the course, we’ll look in detail at models of how people learn from texts and what features (e.g., advanced organizers, examples, metaphors, illustrations, multimedia) enhance learning under what circumstances. We will study and analyze particular types of texts. Some possible examples include an introduction to the concept of gravity; a tutorial for computer software; a self-paced unit in French; adult educational materials in health care; a workshop on sexual harassment in the workplace; or a unit to train someone how to moderate a discussion. We will also look at various methods (e.g., concept mapping, think-aloud, comprehension tests, etc.) that are used to plan and evaluate instructional text. You will do a project, either individually or in a small group (2-3), in which you design, write and evaluate instruction.  
Prerequisites: 76-270 or 76-271 or 76-272 or 76-272.

67-412 18th Century Literary and Cultural Studies  
**Intermittent: 9 units**  
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: From Shelley’s Frankenstein to Darwin’s Origin of Species and H.G. Wells’s The Time Machine, nineteenth-century literary and scientific writers electrified their audiences with narratives of deep time, speculative futures, and powerful evolutionary logics. Print media intensified the impact of these visions then, as the digital media may be doing again today. This course uses traditional print scholarship along with new methods currently emerging in the “digital humanities” to grasp the nineteenth century’s matrix of literary, scientific, and visual culture in a range of fiction and nonfiction texts. Two papers and one visual presentation will be required. (No previous experience in “digital humanities,” which is an introductory topic in this course, is necessary.)  
Prerequisite: 76-101.

67-414 19th Century British Literary & Cultural Studies: Electrifying the Victorians  
**Intermittent: 9 units**  
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2010: From Shelley’s Frankenstein to Darwin’s Origin of Species and H.G. Wells’s The Time Machine, nineteenth-century literary and scientific writers electrified their audiences with narratives of deep time, speculative futures, and powerful evolutionary logics. Print media intensified the impact of these visions then, as the digital media may be doing again today. This course uses traditional print scholarship along with new methods currently emerging in the “digital humanities” to grasp the nineteenth century’s matrix of literary, scientific, and visual culture in a range of fiction and nonfiction texts. Two papers and one visual presentation will be required. (No previous experience in “digital humanities,” which is an introductory topic in this course, is necessary.)  
Prerequisite: 76-101.

67-419 Communication Revolutions & Technologies  
**Intermittent: 9 units**  
What does it mean to be living in today’s communication technology “revolution?” In a time when many forms of communication are digitally based, traveling as bits at speeds on global computer networks? To begin answering that question, we will examine the origins and historical development of various communication revolutions—from the invention of writing, the printing press, the telegraph, and so forth—to the Internet. The discussions and readings will seek to provide a comprehensive overview of how so-called communication revolutions developed, with discussion of cognitive, social, political, economic and technological aspects. We will attempt to put the development of communication technologies in their historical context: How were new forms of communication received? How were they used? How did they affect communication? How did they influence political and social institutions? We will focus, however, on relating historical developments to current digital communication developments. We will take as case studies several new discursive digital formations: digital books, on-line newspapers, and possibly global non-government organizations (NGOs), such as non-profit environmental activist organizations. Along the way we will ask questions such as “What should a rhetorical theory that takes media into account do?” What are some of the challenges that new digital formations present to traditional rhetorical theories (e.g., How is “ethos” established when speakers are anonymous and globally distributed? How is the “public sphere” constituted when Internet search engines dynamically construct it?) (Please see English Dept. for full description.)  
Prerequisite: 76-101.
76-420 Process of Reading and Writing
Intermittent: 9 units
This course is an introduction to the thinking, meaning-making process that underlies reading and writing. It asks: what are the social and cognitive processes, what are the conscious and unconscious problem-solving strategies we use: to comprehend and interpret text, to construct and communicate our own meanings, and to project or discover our readers' responses? In the first half of the course we look at writers and designers as thinkers and problem solvers—facing the challenge of equally creative, meaning-making readers and their own constructive, interpretive processes of comprehension. Understanding (and user-testing for) how readers actually interpret texts is critical to many kinds of writing, from informative websites and PR work, to persuasive applications and powerful arguments. An introduction to the research and theory on reading and writing as a social/cognitive process lets us explore the why behind the what readers do. For instance, you will learn how memory networks, cognitive schemas, and meta-knowledge can shape and are shaped by language and discourse as socially constructed mediating tools. At the same time you will develop a portfolio of methods that track the constructive, inferential process of readers' comprehension. In the second half of the course we turn to you and your own writing as a thinking process engaged in the constant effort to juggle competing goals. You will gain insight into your current problem-solving strategies and develop new ones for doing reader-based writing and design. The final project (which studies your own process on a current writing task) will expand your portfolio of methods into a toolkit of expert strategies for (1) both composing and communication and for (2) user testing and inquiry into the comprehension of real readers that uncovers how others actually interpret what you thought you said. 
Prerequisite: 76-101.

76-422 Theories of Sexuality and Gender
Intermittent: 9 units
Emphasis falls on the "and," the copula between Sexuality and Gender; that is, those theories which either attempt or perhaps are just inevitably drawn into thinking about how the two are related. We will read canonical theories of sexuality—such as Freud's Three Essays on Sexuality and Foucault's Introduction to the History of Sexuality—and canonical theories of gender—such as Robin's "Traffic in Women" and Butler's Gender Trouble. But we will be particularly attentive to those texts that try to understand connections and disconnections between the construction of the two in theory and in practice. To that end, and to ground our theoretical investigations in social historical context, we will focus on two discursive sites: the feminist "sex wars" of the 1980s and more recent preoccupations of feminists with sexuality, such as work by and on sex workers, and the theory and practice of "trans"—both gender and sexuality—from the early modern and contemporary periods. Possible readings in the former area might include Pat Califia, Amber Hollibaugh, or Alice Echols; our "trans" cases might include Henry Louis Gates, Jr., and Valerie John; Female Homiletics, Barbin, Sandy Stone's and Susan Stryker's theoretical work in this area or the biographical writing of "gender warriors" such as Leslie Feinberg. 
Prerequisite: 76-101.

76-425 Science in the Public Sphere
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: Ever since the dawn of the Industrial Revolution and the rise of the technological exhibition, the department for current offerings. Example, Fall 2011: This course will be an in-depth study of James Baldwin's works as well as the writers and thinkers that influenced him. Baldwin's rumination on American life during and after the epoch defining events of Civil Rights Era reflects the great political and cultural transformations the country struggled through. In this course students will read canonical works such as Notes of A Native Son and Giovanni's Room as well as sampling some of the period's rich visual culture of painting, prints, and the decorative arts. While the majority of our materials will be primary works from the period, we will also read classic and recent secondary research on these works and the period, tracing the influence of key cultural theories of gender, sexuality, race, ethnicity and class. 
Prerequisite: 76-101.

76-430 Medieval Literature
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example: Arthurian tales have been told and retold in Anglo-American culture for centuries—they have been appropriated for novels (of which medieval romances are the ancestors), poems, operas, films and visual art of many kinds. The Monty Python group assumed that their satire Monty Python and the Holy Grail would be understood in some detail in order for its humor to be appreciated; the nineteenth century poets and novelists had made the same assumption, it is no exaggeration to say that our own structures of feeling concerning love, sex and adventure still reflect this influence. This course will juxtapose some of the medieval tales that found the genre with their more recent counterparts, for example Chretien's Lancelot with Malory's retelling of that story in Morte D'Arthur, Tennegon's retelling of Malory, and T. H. White's Once and Future King (the basis of the musical and film Camelot). Recent novels such as Scott Spencer's Endless Love, A.S. Byatt's Possession, and Umberto Eco's Name of the Rose are also set beside their medieval antecedents. Full participation in all class meetings, brief responses to our texts, and two prepared papers are required for everyone in the course; an additional hour for the discussion of critical and theoretical texts is offered for grad students. 
Prerequisite: 76-101.

76-431 Chaucer
Intermittent: 9 units
We will read most of Chaucer's Canterbury Tales and his narrative poem Troilus and Criseyde (considered by some the first English novel). Our texts are in Middle English—Chaucer's language is odd-looking, but easily mastered. We will also read some brief accounts of 14th-century institutions and customs (chivalry, religious life, marriage, etc.). Most class discussions will consist of discussions that examine these fictions in relation to the social conditions they imply and the tellers' stakes in the telling. While we are discussing the General Prologue, I will ask each of you to identify theorigins through whose eyes you will try to read each of the tales (in addition, of course, to seeing from your own vantage point). As the course goes on, you will become an expert on one of the social roles portrayed in Chaucer's fictional universe. Required are near-perfect attendance, steady participation, and three papers. Graduate students will meet for an extra hour a week, read additional materials, and write longer papers. 
Prerequisite: 76-101.

76-432 Advanced Seminar in African American Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2011: This course will be a close reading of James Baldwin's works as well as the writers and thinkers that influenced him. Baldwin's rumination on American life during and after the epoch defining events of Civil Rights Era reflects the great political and cultural transformations the country struggled through. In this course students will read canonical works such as Notes of A Native Son and Giovanni's Room as well as lesser known works like One Day When I Was Lost, Baldwin's screenplay for a never-to-be-produced film project on Malcolm X and Little Man, Little Man: A Story of Childhood, a children's novel he published in 1976. Baldwin's works will be read and connect Baldwin's thoughts on literature, race, sexuality and politics to some of his immediate contemporaries like Richard Wright, William Faulkner, Flannery O'Connor and others who had an influence on Baldwin's imagination and craft. 
Prerequisite: 76-101.
76-435 20th Century American Literary and Cultural Studies
Intermittent: 9 units
Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: Before the Beat Generation there was the Lost Generation. Both moments of literary history have an important relevance for our time, and both produced many major literary works. The 20’s, like the 50’s and 60’s were marked by the effects of World War. Gertrude Stein seems to have started the whole generation-naming fad with her comment to Hemingway, "You are all a lost generation." Paul Fussell identifies the cultural effect of WWI as the production of "irony" as the central quality of modern identity. Of course, the "lost" generation wasn’t really lost even if it was searching for new ways of understanding experience. And "beat" generation wasn’t beaten down either. And irony wasn’t invented yesterday even if it still is a dominant mode of modern experience. The last generation to have a really significant name, the beat generation was marked in part by an interest in jazz, and an intense interest in the power of writing. Writing was both a form of recording a response (often oppositional, often ecstatic) to what was going on in the world, and it was also a way of re-inventing the world by discovering some kind of previously hidden secret that only "writing" could uncover. There is a continuing interest in beat writing these days, days which are usually taken to be characterized by a decline in print literature accompanied by a growth in force of electronic media. So, amongst other things, reading the Beats offers us an opportunity to explore our own times, as well as to read (or-read) a body of powerful visionary literature from the recent past. See English Department for full description.
Prerequisite: 76-101.

76-439 Advanced Seminar in American Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Fall 2012: Today, television is "old media." But what was television like when it was "new media?" In this course, we will think about how television transformed American culture. We will look at individual genres, like drama, sitcoms, westerns, variety shows, and game shows. We will watch I Love Lucy, I Remember Mama, The Goldbergs, The Milton Berle Show, Amos n Andy, Queen for a Day, The Phil Silvers Show, the western Cheyenne, The Honeymoons, Leave it to Beaver, and teleplays like Marty and A Man is Ten Feet Tall. We will think about the social and political history of television, including television and the Cold War, television and Civil Rights, and television and electoral politics. Ultimately, the framing question of this class will be a media studies question: how do media technologies change our lives, and how do they NOT change our lives? How is the television revolution similar to our current digital revolution? What can we learn about new media by studying old media?

76-439 Advanced Seminar in Film and Media Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Spring 2012: Neither elections nor the workings of America’s government have been the subject of many films, and the general tenor of those that have been made is somewhat shallowing. One might think that Hollywood, especially given the production code’s prohibition against demeaning authority, would have presented the American political process in a favorable light, but one would be wrong. The relatively few Hollywood films that have taken up the topic have typically adopted a stance favorable from the behavior and opinions of American voters. The basic assumption is that those in power are all a bunch of crooks—or at least a bunch of careerists whose only interest is self-interest. The thesis of this course is that American film has typically presented a cynical view of politics, and we will try to determine why this has been case by studying movies in relation to the politics of the periods in which they were made. Our goal will be to understand lasting patterns in the treatment of politics and politicians, but also to understand changes and to understand how these reflect historical developments in the real world. We will look at American sound-era films that explicitly depict political activities, mostly in the narrow sense of elections and legislation. In addition to mainstream Hollywood productions, we will consider some independent films and documentary. Students will write research papers that explore the historical contexts of a film or films using primary sources such as newspapers, magazines, or video archives. (See Department for full description.)
Prerequisite: 76-239.

76-440 Postcolonial Theory
Intermittent: 9 units
Arjun Appadurai argues that one of the primary transformations in this period of globalization has been in the capacity for people to imagine themselves or their children will live and work in places other than where they were born. Although the novel has long been considered a national form, contemporary novels frequently represent transnational mobility, both in their plots and as global commodities. A significant body of contemporary literary works focuses on international and physical movement across national borders. This global literature course combines literary and theoretical readings to examine the experiences of transnationalism and diaspora. Theories of transnationalism look at the interconnections that cut across nations. The concept of diaspora, a term first used to refer to the movement of a people out of a homeland, has become a way to think about the identities of immigrants, migrant workers, and refugees. Readings for the course will be drawn from a diverse group of writers from around the globe. Literary readings might include works by Amitav Ghosh, Jamaica Kincaid, Nuruddin Farah, Christina Garcia, and Monica Ali; theoretical readings might include works by Salman Rushdie, Paul Gilroy, Gloria Anzaldúa, Arjun Appadurai, Inderpal Grewal and Aarav Brah.

76-443 Contemporary British and American Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: This class is somewhat of a continuation of 76-346 Major Works of Modern Poetry although that class is not a pre-requisite for this one. The terms ‘modern’ and ‘contemporary’ are arbitrary ones in literary history, with ‘modern’ tending to mean roughly the period 1900-1925 and ‘contemporary’ the period after that, 1925—60 or ‘70, roughly. We’ll be looking at the post-T.S. Eliot poets, and there is a wide range of significant, interesting and challenging writers to choose from. Our choices might well include some of the following: Elizabeth Bishop, Delmore Schwartz, Randall Jarrell, John Berryman, Dylan Thomas, Robert Lowell, Robert Duncan, Lawrence Ferlinghetti. Richard Wilbur, Anthony Hecht, Denise Levertov, Kenneth Koch, James Merrill, Robert Creeley, Allen Ginsberg, John Ashberry, Adrienne Rich, Ted Hughes, Sylvia Plath etc. Clearly we will not deal in depth with all of them, but we will considerably widen our range of reading and understanding the best that has been thought and said in recent times. Our purpose in large part will be to become familiar with the major writers of the ‘contemporary’ time frame. We will focus our attention primarily on developing our abilities to read and understand poetry, learning the kind of flexible hypothesis-making needed to deal with imaginative uses of language. We will work on training our ears to hear the particular music of individual voices. Which is to say that we will make the ‘understanding’ of poetry derivative of the musical, or simply artistic, appreciation of it.
Prerequisite: 76-101.

76-444 Studies in Print Culture
Intermittent: 9 units
Topics will vary by semester. Fall 2012: The first modern media age emerged in the eighteenth-century, with new forms of print, orality, and their impact on a growing public. We will consider early modern and Enlightenment practices of communication, media, and the book, then explore Romantic and Victorian transformations in the relation between print and other media, and the relation between print and other media. Theories of transnationalism look at the interconnections that cross borders. This global literature course combines literary and historical readings to examine the experiences of transnationalism and diaspora. Theories of transnationalism look at the interconnections that cut across nations. The concept of diaspora, a term first used to refer to the movement of a people out of a homeland, has become a way to think about the identities of immigrants, migrant workers, and refugees. Readings for the course will be drawn from a diverse group of writers from around the globe. Literary readings might include works by Amitav Ghosh, Jamaica Kincaid, Nuruddin Farah, Christina Garcia, and Monica Ali; theoretical readings might include works by Salman Rushdie, Paul Gilroy, Gloria Anzaldúa, Arjun Appadurai, Inderpal Grewal and Aarav Brah.

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76-446 Allegory
Intermittent: 9 units
Topics vary by semester. Fall 2012: Allegory has both a broad meaning involving any attachment of ideas to literary structure and a narrow meaning in which simple morality tales feature characters like Fellowship and Good Deeds. We will make use of both broad and narrow definitions. The long reign of "realistic" fiction was levered against allegory, which was was often dismissed as simplified, unactively didactic, and "medieval." More recently, sometimes in connection with our current interest in "alternative universes," the term and the concept have taken on a new importance in political discourse and in the interpretation of science fiction. The course will consider some medieval, some twentieth century, and some very recent allegories (mostly on film or video), in an attempt to explore theories of both allegorical and realistic narrative modes. Prerequisite: 76-101.

76-449 20th Century American Literary and Cultural Studies: College Fiction and Film
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2010: College seems a space apart, before you enter the real world. Accordingly, we don’t think of fiction and film that depicts life in college as all that serious. However, there is a growing tradition of fiction of university life, whether of students or professors, in particular, a great many prominent contemporary writers have written novels set on campuses, and a number of major film directors have turned their lights on university life. In this course, we will survey the realm of college fiction and film, from F. Scott Fitzgerald to Michael Chabon. We will try to put together its history, distinguish its major types, and diagnose its contemporary representations. We will also look at relevant historical, theoretical, and sociological works that bear on the university. There will be several short papers and one longer final paper. Prerequisite: 76-101.

76-450 History of Critical Ideas: Problems of Reading, Interpretation & Spectatorship
Intermittent: 9 units
Topics vary by semester. Consult the English Department for the most current description. Example, Fall 2011: "I'm not a lawyer, but..." How many times have you heard this disclaimer, closely followed by a lay analysis of law? This course, an introduction to the cultural study of law for graduate students and advanced undergraduate students, can be seen as an introduction to what goes into the making of such a statement. Where do we get our ideas about law? What do we mean when we say "law"? What counts as law? How does culture influence law, and law, culture? And to what degree must history condition any answers we might be tempted to give? Students in the course will study works in a range of genres (novels, plays, poems, judicial opinions, pamphlets) and develop methods for investigating ways that law and culture have been made by one another from the 16th-century to the present. Readings will include influential theoretical accounts of law (Aristotle, Hobbes, Kant, E.P. Thompson, Habermas, Hart, Derrida, MacKinnon) and canonical texts in "Law and Literature," such as Shakespeare’s Measure for Measure. As a counterpoint to the fiercely ahistorical "law and economics" movement, however, the course will put special emphasis on rooting intersecions of law and culture in their rich historical context, considering both local and international legal contexts (sometimes in highly technical detail) alongside so-called "ephemera" of culture. Students will tackle the especially fruitful "case" of Renaissance Britain before developing their own final research projects, whether on the Renaissance or another period of their choosing. (See dept. for full description) Prerequisite: 76-101.

76-451 Topics in Language Study
Intermittent: 9 units
Seminars focusing on topics in linguistics and discourse studies. Topics will vary by semester. Consult detailed course descriptions available from the Department each semester for details. May be repeated for credit. Fall 2011: The linguistic and social history of the English language from its earliest attestations until the global spread of English and the emergence of the spectrum of "Englishes" in the modern world. We will single out some of the critical periods of change and study them for their linguistic and sociocultural significance. The periods studied will include: the Germanic background; Old English; English from the Norman Conquest (1066) until the introduction of printing (1476); Early Modern English; Present Day English. We will study short texts characteristic of their linguistic and sociocultural features diagnostic of their age, social class, and region. Prerequisite: 76-101.

76-452 Patterns of English Usage
Intermittent: 9 units
Patterns of English Usage is for both graduate and undergraduate students a research course. This means that for all students there is an emphasis on carrying out investigations at first hand and reporting your results. The course is intended to provide experience in recovering data on patterns of English usage from a corpus. It is an introduction to “corpus linguistics,” a set of techniques for studying the distribution of words and phrases as they are actually used in discourse (as opposed to how we might think or imagine they are used without reference to texts). Corpus linguistics is a new field. It incorporates methods and concepts that have only become possible since the advent of large-scale data storage and high-speed search software. It challenges normative grammar by asking whether we are entitled to say that words and phrases have dictionary meanings that are distinct from their uses in discourse. It takes grammar away from authorities and places it in the mouths and pens of users of the language. We will be using the Cobuild (Collins/Birmingham University International Linguistic Database) corpus. By the end of the semester you will have learned the conventions for entering a well-formed Cobuild query, including various wildcard and category-dependent searches, and some elementary corpus concepts such as "collocation" and "transitional probability." You will have learned about some aspects of conventional approaches to English grammar (structural grammar, generative grammar) with which to compare and contrast the corpus approach.

76-453 Postcolonialism Theory
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Spring 2011: Critic David Attwell once characterized a novel about empire as focused on “that moment of suspension when an empire imagines itself besieged and plots a final reckoning with its enemies.” The same might be said of late-nineteenth and early twentieth-century British literature, which was shaped by events taking place outside as well as inside of national borders. Even in the eighteenth and nineteenth centuries, with international trade and slavery supporting the manor house and plantations abroad providing the cotton for British looms, the “England” of English literature spanned the globe. By the first half of the twentieth century, this empire had begun to collapse in upon itself, a process witnessed by writers inside Britain and its colonies. This course will investigate British literature within the international context of global imperialism. Reading Rudyard Kipling’s Kim, we will look consider how the adventure novel shaped an imperial relationship to South and Central Asia that lingers to this day. A section on gothic stories takes us into the realm of popular culture with Conan Doyle’s and H. Rider Haggard’s fiction. As a class, we will trace the torturous path into Self and Other in Joseph Conrad’s Heart of Darkness, and outline the links between colonial empire and international war rendered in Virginia Woolf’s Mrs. Dalloway. These literary works will be read alongside postcolonial theory, including articles by Edward Said, Chidua Achebe, Anne McClintock, and Gillian Beer. Prerequisite: 76-101.

76-457 Topics in Rhetoric
Fall: 9 units
In this unsettled age, when large portions of the earth’s surface are being ravaged by industrialism, when on several continents indigenous peoples are being forcibly uprooted and their philosophers and poets (if not the odd sociologist or two) are asserting that attachments to geographical localities contribute fundamentally to the formation of personal and social identities, when new forms of ‘environmental awareness’ are being more radically charted and urgently advocated than ever in the past” it is unfortunate that [we] seldom study what people make of places. (Keith H. Basso, “Wisdom Sits in Places”) It is sometimes claimed that place is no longer important in human life, now that we spend more and more time in virtual spaces and participate more and more in global economic and social networks. In this course we will test this claim, first by reading and discussing theories of place and space from critical theory and cultural geography, and then by reading about and carrying out case studies exploring intersections between discourse (talk and writing) and place. Our methods will include bibliographic and archival research, discourse analysis, and ethnographic techniques. Students’ projects will draw on your professional and scholarly interests and expertise, and the places and discourse practices you study can range from the local (a workplace for example) to the global (the internet, for example). My project, and our first case study, explores the changing (but persistent) roles of regional US dialects in the formation and use of identities. Prerequisite: 76-101.
76-460 Beginning Fiction Workshop
Fall and Spring: 9 units
Good writers know how to do two very different things equally well - write like a writer and think like one. Writing like a writer is about craft and means gaining absolute control over your material and your tools. It means, for instance, knowing when to use dialogue, when to summarize discourse, it means concentrating on the specific rather than the vague and abstract. It means anchoring your story in a particular time and place, and finding a narrative voice that best tells your particular story. Students will have a story due every week for the first half of the semester. We will workshop several of these stories concentrating our editorial comments on story, development, character, and voice. Your time after mid-semester will be devoted to rewriting and reworking these drafts into accomplished works. Prerequisite: 76-260.

76-462 Advanced Fiction Workshop
Fall and Spring: 9 units
Writing the First chapter of a Novel. Minimum of 35 finished pages to complete the course. Material to be work shopped. Readings from classic novels. Class discussions to be spirited and well-informed. More than three unexcused absences constitute grounds for failure. Prerequisite: 76-460.

76-464 Creative Nonfiction Workshop
Intermittent: 9 units
According to The National Endowment for the Arts, creative nonfiction is "factual prose that is also literary." Memoir, the essay, and literary journalism are just three kinds of work that fit into this very broad, very vital genre. While writers often borrow techniques from fiction, such as narrative, scene, dialogue, and point of view, creative nonfiction is based on actual events, characters and places. In this workshop, students will be introduced to a range of short and full-length works of creative nonfiction and gain experience writing their own stories. While students will be able to choose their own subjects and forms, one of the submissions will be an in-depth story that will involve interviewing and research. Students will have a portfolio of at least thirty pages of polished work by semester's end. Prerequisites: 76-260 or 76-262 or 76-365 or 76-460 or 76-265.

76-465 Advanced Poetry Workshop
This workshop will primarily involve discussions of the poems produced by class members. Grades will be determined by the following: Regular attendance and workshop participation via blackboard and coursework. Three essays on the selected poems of various contemporary poets. A final poetry manuscript which includes a substantial number of revised poems. Prerequisites: 76-265 and 76-365.

76-469 Advanced Screenwriting Workshop
Intermittent: 9 units
This semester will begin with a review of the fundamentals of screenwriting, including character development, scene construction, dialogue, and story structure. Student work will include exercises that encourage writers to take creative risks with genre, tone, character, and structure, one collaborative project, and two short scripts. We will also view mainstream, personal, and experimental narrative films in both American and international cinema. Prerequisite: 76-269.

76-472 Advanced Journalism
Spring: 9 units
This course explores the craft of journalism in the context of the history, traditions and glory of journalistic nonfiction in the United States. It seeks to help you hone your writing and thinking skills as you produce pieces of substance that reflect those traditions and standards. As a published author, foreign correspondent and Pulitzer-Prize winning editor, the instructor has been a foot soldier in print journalism and media management for 30 years. The practical emphasis of the course reflects his extensive and varied background. The course focuses on the four stages necessary to any nonfiction story: idea, concept, reporting and writing. Subjects include how to make news judgments, gather evidence, make word choices, compose stories and interpret events, unpacking the language and vocabulary of the craft of journalism. As part of our exploration of advanced nonfiction styles, we examine the six major genres of journalistic nonfiction: the trend story, the profile, the explanatory, the narrative, the point-of-view and the investigative. We will read, critique, discuss and analyze examples of each genre, and students will produce work of their own in four of the genres. Students are also required to conduct independent research in a topic of their choosing. In addition, we explore journalism's glorious past and its role in the promotion and maintenance of democracy. The last segment of the course examines the evolution of journalism in the digital age and the impact that is having on the media landscape, particularly print. Students will be given assistance and encouragement as they seek outlets for their writings and connections in the media world that could lead to internships and employment. Prerequisites: 76-360 or 76-372 or 76-375.

76-474 Software Documentation
Spring: 9 units
This course teaches best practices for creating software documentation for both internal audiences (use cases, requirements specifications) and end users (online help, guides, marketing collateral). You will learn the importance quality documentation plays in the success of a product and the user's experience, and the importance of understanding (and meeting) that user's needs. The course emphasizes quality task-oriented writing and focuses on the basic skills needed to educate and guide users, while introducing important industry trends like topic-based authoring, single sourcing and reuse, and DITA. Students will complete a series of short homework-assignments and several larger projects to reinforce the principles and provide experience in all phases of creating software documentation, including peer review. Readings and published documentation examples will provide a bridge between theory and practice. No textbook required, but students may be required to purchase necessary software (a DITA editor). Prerequisites: 76-270 or 76-271.

76-476 Rhetoric of Science
Intermittent: 9 units
Theories of nature developed using scientific methods are often perceived as truths discovered by a purely logical/empirical process commanding instant acceptance inside and outside of science. This course approaches science from a more nuanced perspective considering the importance of language, genre, audience, values, argument, and visuals in the production and reception of scientific knowledge both within and outside of scientific disciplines. In the process of this investigation, we will be exploring questions such as: In what ways is science rhetorical? How do the institutional and social contexts of science shape scientific knowledge? What is the difference between arguments made for scientists and arguments made for non-scientists? In what ways do language and argument shape scientific knowledge? What roles do visuals play in scientific argument and knowledge making? Throughout the course we will grapple with these questions, analyzing their scope and implications with the help of various theories from philosophy, sociology, history, and modern and classical rhetoric. Our efforts will be mainly devoted to understanding and explaining the scientific enterprise as an undertaking within which knowledge is produced according to various norms, conventions, and practices in different contexts. Our rhetorical approach will focus attention on how scientists use language to represent the world, develop new ideas, argue and communicate their work among themselves and to the public. The course will include a series of connected assignments engaging with rhetorical scholarship and methods for analyzing how you will develop skills for producing scholarly writing engaging with questions/topics examined in the course. Prerequisite: 76-101.
76-479 Marketing, Public Relations, and Corporate Communications

Spring: 9 units
Effective marketing and communications are essential to the success of businesses, non-profit agencies, academic institutions, public interest groups, and other entities that have a shared purpose and identity to promote. This course explores marketing and communications in organizational settings, where professional communicators manage relationships with a wide variety of constituencies: customers, investors, news agencies, employees, members, volunteers, local communities or government agencies. To succeed, communicators must be able to identify and articulate the communication needs of the organizations they represent, develop well-informed strategies for advancing organizational objectives, think and act quickly in high-pressure situations, and write clear and persuasive prose. In this course, you will develop the written and oral communication skills needed by a professional communicator in an organization. You will learn to identify and define a coherent, integrated strategy for all of an organization’s communications and to devise and apply effective marketing and public relations tactics in traditional and social media for achieving business objectives. You will gain practice in writing op-ed essays, press releases, critiques of organizational communications, and marketing and communication plans.
Prerequisites: 70-340 or 76-270 or 76-271 or 76-272 or 76-372.

76-481 Writing for Multimedia

Fall: 12 units
There is increasing demand for professional/technical writers who understand multimedia and its communicative possibilities. This class will provide students with the opportunity to develop the ability to analyze and create multimedia experiences. Students will be introduced to the basic concepts and vocabulary of multimedia, as well as the practical issues surrounding multimedia design through a series of hands-on projects involving various contexts. We will explore what it means to write in multimedia and how the elements of time, motion and interactivity can help writers expand their communicative skills. Assigned readings will complement the projects in exploring document design from historical, theoretical, and technological perspectives. Class discussion and critiquing are an essential part of this course. While students are not expected to become masters of multimedia software, Adobe Flash will be taught in the class in order to provide them with the basic skills necessary to complete assignments and explore multimedia possibilities.
Prerequisites: (76-270 or 76-271) and (76-391 or 51-261 or 51-262).

76-482 Comparative Rhetoric

Intermittent: 9 units
This course serves a two-fold purpose. It attempts (1) to address the theoretical and methodological issues in cross-inter-cultural communication from a rhetorical point of view and (2) to examine critically the way comparative studies of rhetorical traditions/systems are currently conducted. In particular, it is concerned with the rhetorical problems we encounter in trying to write, argue, and persuade across languages and cultures. And it aims to take a close look at the need for rhetoric to rethink its own identity, purpose, formation and agenda in an increasingly multicultural and globalized world.

76-483 Corpus Analysis in Rhetoric

9 units
This course investigates methods for analyzing rhetoric as it mainly exists in digital environments (e.g. blogs, newsgroups, homepage, political sites, facebook and so on). The focus will be on verbal rhetoric, but students who wish to analyze visual rhetoric interactively with verbal rhetoric will be welcome to do so. In the first part of the course, we will review various methods for analyzing digital texts descriptively (viz., concordance, collocate and keyword analysis) and inferentially, through multivariate analysis (e.g., manova, factor analysis, discriminant analysis, cluster analysis). To learn these methods, in the first half of the course, we will use simple textual data sets supplied by the instructor. In the second half of the class, students will choose their own digital environments to analyze and they will be expected to write publishable-quality rhetorical analyses of these environments. To meet this expectation, students will need to do considerable background research in the digital environments they are studying.
Prerequisite: 76-101.

76-486 Argument Theory

Intermittent: 9 units
The difficult part in an argument is not to defend one’s opinion, but rather to know it.” — Andre Maurois This seminar will be an in-depth exploration of theories of argument and assumes some prior knowledge of coursewok in argumentation such as acquired in 76-373/377. As the above quote from Maurois suggests, we will take a broad view of the concept of “argument” and examine its role as a discursive means of truth seeking, knowledge creation, and decision-making, not just as the practice of using language to justify or refute a conclusion. The goal of the seminar is for participants to acquire the concepts needed to read the current research/scholarship on argumentation with understanding, to apply that research to the analysis of arguments, and to be positioned to contribute to that research. We will begin with a brief history of the classical Greek writings on logic, rhetoric and dialectic, especially the writings of Aristotle. There are questions from that tradition that endure to this day: What does it take for a conclusion to be well supported? What criteria should be govern acceptance of a conclusion? We will also examine two landmarks in the contemporary study of argumentation, Perelman and Olbrechts-Tyteca’s The New Rhetoric and Toulmin’s The Uses of Arguments, both published in 1958. These works can be seen as taking the first steps toward studying argumentation functionally, as a linguistic activity that occurs in contexts. We will also look at theories of acquisition of argumentation skill and implications for pedagogical practice. We will then move to current questions in argument theory such as the relation between formal and informal logic, argument quality and cultural difference, and so forth. Along the way we will ask questions such as, “What should a theory of argumentation do?” (See Department for full description.)
Prerequisite: 76-101.

76-487 Web Design

Fall: 9 units
* Students taking Web Design must register for both 76-487 and 76-488 or receive permission from the instructor to omit the lab. As the Internet has increasingly become an integral part of professional and technical communication in all organizations, writers entering the workplace are expected to have a broad range of web design skills to complement their expertise in writing and design for print. Thus, we’ve designed this course to help writers learn the broad range of skills needed to develop communication materials that are tailored for the web. In particular, the course focuses on the planning, design, and testing of the visual and verbal content typical of contemporary websites. As a member of the class, you’ll participate in a guided, semester-long web design project, which is scaffolded with a series of group and individual assignments. The project begins with an introduction to user-centered methods for understanding the audience (users), where you will learn and practice foundational user-centered design methods through readings and a series of hands on exercises, including interviews, and observation of actual users. You will also learn theories and methods for developing effective information architecture, including organizational schemes, navigational design, labeling, form design, and visual design. Working in groups with other students, you will over the course of the semester, develop a prototype of a small website, which will be evaluated through user testing at the end of the semester. While we focus primarily on the activities described above, we’ll also discuss sound and animation, emerging technologies such as Web 2.0 and Mobile Web, and social media.
Prerequisites: (76-270 or 76-271 or 76-272 or 76-391 or 51-261 or 51-262) and 76-488.

76-488 Web Design Lab

Fall: 3 units
Lab exercises for Web Design include the following: basic HTML, images, tables, animation, image maps, interactive forms, Web interfaces to databases, and basic Javascripting. All students must do the lab exercises. The exercises are designed so that those students who already know particular topics (e.g., basic HTML) do not need to attend the lab session. Students who would like guided practice in doing the lab exercises must attend the lab session. Lab sessions take place in a computer cluster.
Prerequisites: (76-270 or 76-271 or 76-379 and 76-381 or 76-382 or 76-383).
76-491 Rhetorical Analysis
Intermittent: 9 units
Students in this course will learn various approaches to analyzing discourse artifacts from a rhetorical point of view. Early in the course, students will identify an artifact or artifacts they wish to analyze. As a baseline, we will all learn how to do cohesive analysis, which is a new technique for dividing a rhetorical artifact into "cross-sections" based on similar semantic domains. From there, students will be encouraged to explore their own methods of analysis based on two required books for the course and reviews of literature. At midterm, students will be expected to hand in a polished 10 page cohesive analysis of their artifact, which will count for 25% of the grade. For their final project, students will present on other analytic methods they have employed to expand their analysis and, for the final assignment, they will hand in a polished 15 page paper that describes that analysis. The presentation and final paper count for 50% of the grade, with class attendance, participation, and homework making up the final 25%.
Prerequisite: 76-101.

76-492 Rhetoric of Public Policy
Intermittent: 9 units
In traditional public policy approaches, each step of the policy process from defining a problem to making a case for its solution is assessed in reference to rational models of economic and political actors. This course, however, takes a less conventional rhetorical approach to public policy which focuses attention on the values, beliefs, and argument structures associated with issues as a means of assessing them and as a method for moving forward with effective arguments towards their resolution. Towards this end, we will be studying the theories and analytic methods of both classical and modern rhetoric as well as modern public policy theory. Over the course of the semester, we will combine knowledge and techniques from both fields to examine the development of the public policy debate over the safety and efficacy of nuclear power as a solution to the current environmental and energy security challenges faced by the United States. No previous experience with public policy or knowledge about nuclear power is necessary for this course. Those with experience are welcome.
Prerequisite: 76-101.

76-494 Healthcare Communications
Fall: 9 units
Healthcare Communications is writing-intensive course designed for students interested in how healthcare information is developed by researchers, healthcare providers and writers and communicated to patients and their families, the general public, and other experts. Throughout the course, we will explore where people find medical information, how they use and evaluate it, and what challenges writers face in supporting informed healthcare decisions while communicating ideas that can be complex, provocative and sometimes frightening. We will read and discuss published literature dealing with issues in health literacy, clinical research, and patient care. We will also learn the basics of reading, understanding, and interpreting the research literature and communicating research findings to non-experts. Early in the semester, you'll choose a medical area of interest that you will research using sources such as journals, articles, books and web sites, as well as direct contact with appropriate medical, healthcare, and/or research professionals. For your final project, you will write and design materials that will meet a specific need or gap you identify in existing information. The final project could be a magazine article, a website, patient education material such as brochures or training materials, or another vehicle that emphasizes accurate, informative and engaging writing. In addition, there will be several short writing assignments to build the research and writing skills needed to effectively communicate healthcare information. A background in health, medicine or science is not necessary for this course, but a willingness to learn about these areas is essential.
Prerequisites: 76-270 or 76-271 or 76-272 or 76-395.

76-511 Senior Project
Intermittent: 9 units
Seniors in all four majors within the English Department may, with faculty permission and sponsorship, design and complete an original, student-planned Senior Project. Creative Writing majors may work on a book-length manuscript in fiction or poetry. Students in all majors within the Department may also, with the permission of a faculty advisor who will supervise a seminar, sponsor the project, develop and complete senior projects that involve either traditional academic research or investigations of problems in professional or technical communication.
67-250 The Information Systems Milieu
Fall: 9 units
Information systems (IS) are changing work practices, reshaping organizations, transforming cultures, and giving new meaning to the ways we see the world. This course is designed to help students understand the role of IS in modern society and the means by which these systems are created. It provides not only a framework for understanding information and information systems, but also a language to identify their dynamic complexities and interdependencies. Topics include: current trends in IS, structured approaches to the creation of IS, corporate IS competitive advantage, business process improvements/reengineering, eCommerce and the digital economy, knowledge management, decisions support systems, and the implications of IS for people, organizations and society. Classes will use a combination of lectures, class discussions, reading assignments, case studies, group projects, and “hands-on” work in database design. This course is a required professional core course for sophomores in the IS major. Non-IS sophomores may enroll by special permission.

67-260 Visualizing Complex Information
6 units
This studio course meets two times per week and teaches students how to display complex information in clear and compelling ways. Students will be taught the organizational principles of good information architecture. Assignments are centered around the visual display of complex information, with a strong emphasis on developing structures, or grids to support the display of data. Legibility, visual organization, and typographic hierarchy are tools that are implemented in all assignments. We will begin to explore the relationships between form & content, and type & image. Students will learn how to make appropriate creative decisions for large posters and small business cards, as well as multiple-page documents. Design is a process and students must show their work as it evolves. This process includes: analyzing text, organizing content, visual organization, generating pencil sketches, and producing computer iterations. Personal growth as it relates to assignments is paramount to the students’ success in this class, regardless of the level of experience coming in to the class.

67-272 Application Design and Development
Spring: 9 units
Prerequisites: 15-121 or 15-122.

67-301 Networks and Telecommunications
Spring: 6 units
This course will introduce students to the basics of telecommunications, including voice, data, video, and wireless, with an emphasis on data. The course will cover both technical and business aspects of networking, and will consider regulatory and industry factors affecting telecommunication networks. Students will be introduced to the concepts and terminology of networks, including layered network models, and to practical issues involved in designing, managing, and using networks and network applications. Learning will take place through assigned readings, current issues and events in networking, class participation, and homework assignments. Grades will be based on examinations, homework assignments, and contributions to classroom discussions. Junior or senior class standing required. Prerequisites: 67-371
Prerequisite: 67-371.

67-304 Database Design and Implementation
Spring: 6 units
This course provides an introduction to database design and implementation with a primary focus on the relational model. By the completion of this course the student will be able to appropriately use database design and implementation tools (the relational model, E-R models, normalization, and SQL) and apply knowledge of both technical and business issues related to database design and implementation to generate and evaluate alternate solutions to business situations. The course will also cover database dependability, reliability, availability, recovery, architectures, and distributed databases. Current topics in databases such as object-oriented and object-relational databases as well as data warehousing and data mining will also be presented. Projects will be completed using a relational database management system such as Oracle, DB2 or Microsoft SQL Server.
Prerequisites: 67-271 and 67-272.

67-306 Special Topics: Management of Computer and Information Systems
Intermittent: 6 units
The course will provide a thorough understanding of the many responsibilities for managing technology by the organization IT resource, executives, managers, and functional end users. Concentration on IT plan and budget development with associated management, IT roles and responsibilities, system development and operations best practices, security management, IT procurement with emphasis on service and product agreements, vendor relationships, project management, and business continuity/disaster recovery. Junior or senior class standing is required. Coursework in information systems, software design, project management, or related job experience is strongly preferred, but not required due to the managerial, rather than technical, nature of the course.

67-309 Special Topics
Spring: 6 units
Special Topics: Information Assurance and Security [Power to the Edge: Challenges to systems survivability in a net-centric world] This course is an overview of increasingly important aspects of systems development, operation and sustainment, namely information assurance, software assurance, survivability and security. As more and more functionality and dynamic decision-making are pushed down and out into the organization (power to the edge), assurance and security concerns, with their organizational and human dimensions, impact the fidelity of the data and the very survival of the organization. Topics include overview and definitions, defense in depth, legal and policy issues, principles of survivability and information assurance, risk management, insider threat, vendor and outsourcing issues, incident management and forensics. This class is a combination of lectures, readings, and discussion groups. Students will leave the course with an understanding of the various concepts and their impacts on systems and the organization itself. Prerequisites: Junior or Senior class standing and at least one programming course (15-110 or equivalent)
Prerequisites: 15-110 or 15-121 or 15-112.

67-311 Database Design and Implementation
Intermittent: 9 units
Managing large databases is a core task in many information systems. In this class students will explore the underpinnings of databases as well as learn how to more effectively manage databases. Topics include relational algebra and advanced data modeling, advanced SQL queries, handling transactions, performance tuning, creating triggers, views and stored procedures, and much more. In the last part of the course we will explore NoSQL databases such as MongoDB and Redis, understanding their strengths and weaknesses as well as how to integrate them into web-based applications. Prerequisites: 67-272 or permission of instructor
Prerequisite: 67-272.

67-327 Web Application Security
6 units
This is a technical course designed to help students learn how to exploit web applications and to be better able as developers to defend against such exploits. The course covers the process of hacking a web application, starting with initial mapping and analysis, followed by identifying common logic flaws in web apps, database and network exploits, common SQL injections, and the like. This hands-on course requires students to be familiar with a popular web application framework or language (such as Ruby on Rails, PHP, Django/Python, ASP.NET or the like). Prerequisite: 67-272 or permission of instructor
Prerequisite: 67-272.

67-328 Mobile to Cloud: Developing Distributed Applications
6 units
Web 2.0, Mashups, Mobile Apps, and Cloud Computing are just a few of the new terms people are using to describe emerging technologies for building complex, distributed applications. Protocol standards, web services, open-APIS, increasingly more powerful mobile devices, and the Internet have enabled new possibilities for weaving complex applications using globally-distributed data and computing resources. Application development has largely left any single computer, and is distributed across a wide range of hardware and software platforms. This class will explore these developing technologies and models for structuring their complexity, while building projects that go from mobile to the cloud.
Prerequisite: 67-272 or permission of instructor
Prerequisite: 67-272.
67-329 Contemporary Themes in Global Systems
Spring: 9 units
Globalization and outsourcing of information systems (IS) is a mainstay of the business environment. The decision to outsource software services to providers in distant places has many risks and thus careful management of critical success factors is essential. Likewise, products and services are being developed and delivered by teams of people in diverse locations working together. Management of these sourcing models and human capital relationships will be an increasingly important skill for students expecting to fully participate in the emerging IS marketplace of the 21st century. This course introduces the effective fundamentals of global project management and the mechanics of sourcing arrangements including offshore outsourcing. Students will also examine the effects of human diversity and cross-cultural considerations in the creation, use and management of information systems. A combination of readings, participation in class discussions, and non-technical collaborative projects will be expected of class participants. Students must have sophomore standing or higher and have not successfully completed 67-325 and 67-326.

67-330 Technology Consulting in the Community
Spring: 9 units
Technology Consulting in the Community: In this course, the student develops technical consulting and management skills while collaborating on-site with a community leader of a non-profit community organization or school. This service-learning course has students analyze a complex organization, then design and implement a work plan that will expand the organization’s capacity to use information technology. Student consultants do not merely provide IT support, nor do they focus on system development. Rather they focus on solving organizational problems using IT solutions. In doing so, they may develop a system, or adapt open source or commercial tools as appropriate to the situation. Throughout the semester, students develop a consulting report. They learn how to use this working document to collaborate with others and to think through and communicate a strategic technology plan. Students also experience how urban community organizations function, seeing the valuable benefits these organizations provide to society. Prerequisites: 76-101 and (15-121 or 70-451). At least sophomore standing.
Prerequisites: 76-101 and (15-121 or 70-451).

67-331 Technology Consulting in the Global Community
3 units
PREREQ: Admitted ONLY BY Permission of Instructor.

67-344 Organizational Intelligence in the Information Age
Fall: 9 units
Across all organizations people find that the actions they take affect, and are affected by, the technology, norms, procedures, culture, and members of the organization. In order to navigate through this organization, global and international agents need a better understanding of social and organizational intelligence. How do organizations (and the people who populate them) acquire and then process information? In what ways have new technologies altered the norms, procedures, and culture of organizations? How do leaders successfully guide their organizations through a world where new information and new technologies are constantly being produced? This course is about information assessment and analysis in organizations, and the way organizations are transformed by technology.

67-360 Applied Analytics
9 units
Businesses and organizations are currently in a paradoxical situation where they are drowning in data but starving for knowledge. From tracking purchases at traditional retail stores to logging browsing patterns at online stores, modern business are adept at collecting data about their customers. The analytics challenge is how to interpret and distill this data into actionable knowledge. This class will introduce you to a range of technologies and methods for extracting business intelligence from data to anticipate customer needs and create new opportunities. We will examine how various business processes can be improved with case-studies and examples from the fields of fraud detection, movie-box office, credit scoring, customer churning and retention. These are some of the analytic strategies used by companies such as Google, Amazon, Netflix, and Facebook to better understand and target their customers. The overall objective of this class is to introduce you to practical business analytics skills which are in high demand in the current job market. The class will be hands-on with various analytics tools such as the SAS Enterprise Miner. <p>
This course may count toward the Decision Science and Rational Choice (old curriculum) and Quantitative Analysis and Research Methods (new curriculum). Students could also use it as an IS elective for the professional core or content area (Quantitative Analysis and Research Methods). <p>
Prerequisite: 15-121 or 15-122 or 15-211.

67-370 Intelligent Decision Support Systems
Spring: 9 units
In this course we will study various methods for augmenting human decision making. We will focus on the key ideas of several business intelligence technologies and the value they can bring to an enterprise. The technologies we will study include classic symbolic AI methods (rule-based systems, case-based reasoning), connectionist approaches (neural nets), evolutionary approaches (genetic algorithms), inductive approaches (statistical machine learning nearest neighbor, support-vector machines), data mining (constructing decision trees and association rules), and collective intelligence methods (collaborative filtering). While this is not a programming intensive course, we will be using several software systems and libraries implementing these methods. By running experiments with these systems and libraries we will focus on how these technologies can support decision making in tasks such as classification, clustering, prediction, optimization, design, and recommendation. This course may count toward the Decision Science and Rational Choice (old curriculum) and Quantitative Analysis and Research Methods (new curriculum). Students could also use it as an IS elective for the professional core or content area (Quantitative Analysis and Research Methods). Prerequisite: 15-121. Prerequisite: 15-121.

67-371 Fundamentals of System Development I
Fall: 9 units
This is an introductory course in software systems analysis and design and project management. The course will cover contemporary themes and issues involved in developing high quality software systems that meet users’ expectations. Students will learn the basic theory, techniques and skills that systems analysts need to develop and document requirements and project plans for complex information systems projects. Since software system development practice is a rapidly evolving area, a cross-section of current, as well as time tested best practices methods will be presented. The course consists of these main components: overview of systems analysis and design, lifecycle and process issues, requirements articulation with use cases, object models and diagramming and documentation tools and techniques, and project management, including issues of software quality and metrics. Concepts will be mastered through a combination of assigned readings, class attendance, homework assignments and mini-projects. This course is a professional core requirement, and is open only to IS juniors who have completed 67-272.
Prerequisite: 67-272.

67-373 Software Development Project
Spring: 12 units
This is a lab course providing experience working with a small project group to design and analyze a computer-based information system. To illustrate and provide practice utilizing the tools of structured analysis and design, the class is divided into groups which are assigned to analyze, design and build an information system.
Prerequisites: 67-272 and 67-371.

67-390 Independent Study in Information Systems
All Semesters
Independent studies are opportunities to engage in research with a faculty member to advance your learning in certain areas of interest. Information Systems students may enroll in independent study for 3, 6, 9, or 12 units of academic credit by obtaining a faculty sponsor who will oversee the academic component of the coursework, monitor progress, and assign a final grade.

67-475 Information Systems Applications
Fall: 12 units
In this course, students design and implement a usable information system for a client. The client may be affiliated with the university, government, business, or non-profit agency. Students will be assigned to teams to work on these projects, and will produce operational, fully documented and tested, computer-based information systems. The projects will be supervised by CMU faculty and, when possible, by project clients.
Prerequisite: 67-373.

HSS Interdisciplinary Courses
66-221 Legal Topics: Introduction to Intellectual Property Law
Interim: 9 units
Topics for this course vary, to include such foci as intellectual property, introduction to U.S. law, great American trials, and the U.S. Constitution. Topics and courses are designed to be broadly relevant and interesting for university undergraduates, and not narrowly tailored for students interested in law school.
66-320 Internship
All Semesters
Internships-for-credit allow students to apply course-based knowledge in a non-classroom setting, under joint supervision and evaluation by an on-site supervisor and a faculty sponsor. Approved internships must confirm to college guidelines for internships-for-credit, and are available by permission only arranged through the Associate Dean’s Office in Baker Hall A57.

66-501 H&SS Senior Honors Thesis I
All Semesters: 9 units
This sequence is open only to those seniors who have been admitted to the H&SS Senior Honors Program. This is the first semester of a two-semester sequence that culminates in an original, year-long independent research or creative project. Thesis topics are selected by faculty and students.

66-502 H&SS Senior Honors Thesis II
All Semesters: 9 units
This sequence is open only to those seniors who have been admitted to the H&SS Senior Honors Program. This second semester course is the culmination of an original, year-long independent research project. Research topics are selected by faculty and students.
Prerequisite: 66-501.

HSS Interdisciplinary Courses

65-201 Humanities Scholars III
Fall: 9 units
65-201: HSP III: Diaspora and Center Case Studies from the Hispanic-Jewish Experience This course is an introduction to the nature and scope of the Hispanic-Jewish Diaspora and to the variety of ethnicities, languages and cultures within it. Using primary source material and secondary readings, this course will examine the development of the concepts of Diaspora, homeland, and exile in the Hispanic-Jewish experience. If, as many scholars argue, the Jewish Diaspora experience is archetypal, it is critical to understand how constructions of identity have changed over time. Furthermore, taking as a point of departure Max Silverman’s contention that “Jew” is one of the most malleable signifiers, we will explore how “Jewishness” is imagined by Hispanic Jews and non-Jews, and the significance of memory, migration and hybridization through literature, theater, and music. This course fulfills the General Education Category "Reflecting: Societies and Culture." Prerequisite: 65-102.

Heinz College Wide Courses Courses

94-700 Organizational Design & Implementation
Fall: 6 units
This course draws on insights and knowledge about organizational behavior with an eye toward using such information for managing in complex organizations. It is intended to provide managers with skills and perspectives that will enable them to work successfully in organizations. Specific topics will include motivation, job design, group processes, building bases of power in organizations, managing conflict and the relationship between the organization and its environment.<a href="http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=26">Read More</a>.

94-701 Business English
Fall and Spring: 6 units
To be a strong writer you need to master grammar and style. This course revisits some important fundamentals of grammar and shows their application in a variety of professional documents. In so doing the course reviews basic grammar and its use in creating clear concise coherent writing that demonstrates an understanding of purpose audience tone design and organization. It does this through the review and writing of a number of business documents from email to business letters and proposals. <a href="http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=429">Read More</a>.

94-705 Health Economics
Spring: 12 units
This course will teach the student to use economic analysis to understand critical issues in health care and health policy. We will address issues such as the following: 1. What factors best explain the level and rate of growth of U.S. health expenditures? 2. Does the recent high rate of growth of U.S. health care expenditures make U.S. firms less competitive in international markets? 3. What are some of the likely consequences (intended and unintended) of the proposed reforms to Medicare? 4. Can physicians induce demand for their services? 5. What are the impacts of managed care on the health care system? 6. Do strong affilonations between physicians and health plans hurt competition? The student who successfully completes this course will be able to: 1. Identify the flow of resources in the U.S. health care system how purchasers pay for their services and how providers obtain their revenues. 2. Understand the value of health and health care. 3. Evaluate how health care resources should be allocated. 4. Describe the structure of the health insurance industry explain the incentives facing insurers understand the strategies they use to compete and their impacts on social welfare. 5. Understand the demand for medical care and what role providers play in shaping this demand. 6. Explain the economics of managed care and describe how competition works in health care. Class will consist of lectures and group presentations. Evaluation will include homework problems group projects and exams. This course will interest any individual planning a career in health or related industries. It will also be of interest to students who wish to understand how economics is applied to some of our most prominent and contentious policy issues. Skill<a href="http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=32">Read More</a>.

94-706 Healthcare Information Systems
Spring: 12 units
In this new era of managed care with its emphasis on improving cost efficiency without risking quality of care information technology has emerged as a powerful force in helping to achieve multiple goals within health care organizations. The explosive advances in information technology combined with the current climate for health care reform has created the need for skilled individuals who can develop understand manage and integrate medical information systems in organizations. This course will explore the concepts and application of major information systems methodologies and approaches in the delivery of modern health care systems. Imaging applications electronic data interchange integrated delivery systems computerized patient records artificial intelligence and expert medical systems decision support systems and Internet based applications are some of the areas that will be covered. A semester-long group project that synthesizes different topics will be a required component of the course.<a href="http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=133">Read More</a>.

History Courses

79-104 Global Histories
Fall and Spring: 9 units
People throughout the world are caught up in multiple processes that cross national boundaries, link distant regions, and in many cases, encompass the planet as a whole. These transnational, transregional, and planetary processes are the latest incarnations of interactions that have been developing for a long time. If you want to understand the world today and where it might be heading, it’s crucial not only to think globally but also to relate current global processes to comparable processes in the past. This course offers you several options for expanding on the skills you need to think globally through the medium of history. As their descriptions indicate, the differently titled lectures vary in their subject matter and the particular pathways they provide for exploring global processes. However, they all involve a mix of lectures and recitations; they have similar amounts of reading; and they all use essay-writing as the primary medium of assessment. Most importantly, they all strive to help you: (1) identify and assess the varied ways that scholars interpret global interactions as they unfold through time; (2) bring together insights from diverse fields in the humanities and social sciences to illuminate the development of global connections, differences, and divisions; (3) read, listen, discuss, take notes, and craft written arguments supported by different kinds of evidence; and, above all, (4) use explorations in global histories to engage the workings of the world today and in the future. See the H&SS General Education Website “First Year Experience” for descriptions of specific sections: http://www.hss.cmu.edu/gened/
79-112 Race, Nationality, and Culture in American Society  
Intermittent: 9 units  
This course examines the interplay of race, ethnicity, and nationality in the development of the United States. We evaluate the comparative role of these factors as different groups interacted over time in American society. This course pays close attention to larger socioeconomic, demographic, and political processes that shaped the lives of all Americans.

79-113 Culture and Identity in American Society  
Intermittent: 9 units  
This small discussion course traces ideas about individualism in the U.S., from colonial times through the 20th century. We will focus on three main themes: 1) the relationship between work and identity; 2) changing definitions of success and failure; and 3) the historical origins of contemporary attitudes toward 1 & 2. In short, we will study the economics and emotions of the American dream: how class, race, gender, occupation, and ambition shape our identities. Readings include The Autobiography of Benjamin Franklin; studies by Alexis de Tocqueville and Max Weber; writings of Frederick Douglass, Ralph Waldo Emerson, Herman Melville, and Henry Thoreau; Kate Chopin’s The Awakening; Andrew Carnegie’s Gospel of Wealth, Arthur Miller’s The Death of a Salesman, and other works. Grading is based upon a readings journal, three short essays and a longer final paper, and on participation in discussion.

79-125 Disastrous Encounters  
Intermittent: 9 units  
Disastrous Encounters explores the complex interaction between human beings and their environment by examining incidents in which those disasters have proven destructive or fatal to humankind. By the end of the class, students will be able to: •: Explain the scientific principles behind “natural” disasters, including volcanic weather, global climate change, volcanoes, earthquakes, tsunamis, river flooding, famines, and diseases. •: Analyze to what extent a given disaster is in fact “natural” at all, but rather was either caused by or exacerbated by human actions. •: Draw connections between different types of disasters, recognizing that major disasters often produce predictable secondary disaster effects. •: Write strong analytical essays. •: Read documents critically, especially in terms of the author’s agenda and the author’s likely biases.

79-155 Freshman Seminar: Rethinking Race: The Shaping of the African American Experience  
Intermittent: 9 units  
This course examines major issues in the development of African American urban life, from slavery to recent times. Students will explore major works that have shaped the field of African American urban history: pinpoint the strengths and weaknesses of past scholarship; and develop their own theoretical and methodological approach to the subject. In addition to weekly discussions of assigned readings, students will write a 15-20 page paper based upon an examination of primary sources in various published sources, microfilm, and archival collections at Carnegie Mellon and the University of Pittsburgh.

Intermittent: 9 units  
This course focuses on problems of food shortages and famine in the context of population systems. We use the historical record from the European past to show how population systems functioned to keep resources and needs in balance, and how they often failed. This requires that we understand customs and practices regarding the family, marriage, migration, and reproduction as well as patterns of mortality. We study the basics of T.R. Malthus’s theory of population, and see whether and how his work sheds light on population history over the long-term. We compare findings on Western Europe with societies in other regions of the world in both past and present. Topics include studying the relation between economic and demographic systems and the actual histories of “demographic catastrophes” such as epidemics and famines (including the Irish famine of the 1840s); newer theories of how and why famines happen; and current concerns about global food markets.

79-162 Freshman Seminar: “Slavery” and “Freedom” in African History?  
Intermittent: 9 units  
Lying in a society still struggling to come to grips with its own history of slavery, American scholars have often imposed words like “slavery” and “freedom” onto African contexts. But, such labels have the effect of masking dynamic social institutions in pre-colonial Africa. This course will turn this terminology on its head by delineating the relationship between “slavery” and “freedom.” Kinship, dependency, and marginality will look historically at institutions which are integral to African societies, such as patron-client relationships, marriage, and pawning. It will interrogate the multiple ways that these institutions functioned before the period of the transatlantic slave trade and the multiple ways that African communities transformed their institutions in response to it. Students will engage a variety of historiographical debates in secondary sources and first-hand testimonies of “slave’s” primary sources.

79-165 Freshman Seminar: The Historian as Detective and Storyteller  
Intermittent: 9 units  
Early on Saturday of Memorial Day Weekend 1937, three young men set out in a used car from their home in Bayonne, New Jersey to New York to pick up and bring home another hometown friend who was finishing his freshman year at the University of Notre Dame. They called themselves "The Rover Boys." They kept a typewritten daily journal of their trip, which they stretched into a 15-day journey that took them west to South Bend, south to New Orleans, and northeast back home to New Jersey. This course offers a set of first-hand accounts from this recent past time and place in America, witnessing through their eyes, diverse parts of the country, and connecting first-hand with various elements of the period’s history. Moreover, these young men were about that age (19-20 years old) when, in modern American society, adolescents transition to adulthood – graduate from high school, go to college, or to work; perhaps marry and start families; perhaps leave home to set out on their own. In other words, they “come of age.” This course will use the coming-of-age concept as a framework to examine the period of these boys’ lives from their birth to their Spring 1937 journey, while also using this conceptual framework to examine the current generation of 19-year-old Americans, and their coming-of-age experiences. Particular themes will include: politics and economics; the role of government in modern society; the role(s) of technology in societal change; manners, morals and popular culture; diversity; science and religion; and the art of historical story-telling. We will also focus on the Log and, through creative historical research, expand and illuminate its references to the period’s history. The course has no prerequisites, but it is assumed that its students will have had at least 1 year of U.S. History in high school.

79-168 Freshman Seminar: The Juvenile Court: Past and Present  
Intermittent: 9 units  
This course will track the development of an authentically American institution, the juvenile court, from its late 19th century origins to the present day. We will integrate historical, legal, sociological, and cultural perspectives in tracking the court’s evolution, culminating in a careful look at how recent nationwide reform movements are playing out in Pittsburgh. Readings will include a wide variety of secondary and primary historical sources from different time periods. We will also view and discuss several feature and documentary films (including Frederick Wiseman’s 1973 classic, “Juvenile Court”). As opportunities develop, we may also observe at the Allegheny County Juvenile Court, as well as hear from Court practitioners as guest lecturers. The course will be discussion-based. I will do very little formal lecturing, and I expect students to take on increasing responsibility as the semester progresses for launching and guiding class discussions. Evaluation will be based on in-class mid-term (25%) and final exams (25%), several oral presentations and brief writing assignments (25%), and contributions to class discussion (25%).

79-169 Freshman Seminar: Culture and Identity in American Society  
Intermittent: 9 units  
This course traces ideas about individualism in the U.S., from colonial times through the 20th century. We will focus on three main themes: 1) the relationship between work and identity; 2) changing definitions of success and failure; and 3) the historical origins of contemporary attitudes toward 1 & 2. In short, we will study the economics and emotions of the American dream: how class, race, gender, occupation, and ambition shape our identities. Readings include The Autobiography of Benjamin Franklin; studies by Alexis de Tocqueville and Max Weber; writings of Frederick Douglass, Ralph Waldo Emerson, Herman Melville, and Henry Thoreau; Kate Chopin’s The Awakening; Andrew Carnegie’s Gospel of Wealth, Arthur Miller’s The Death of a Salesman, and other works. Grading is based upon a readings journal, three short essays and a longer final paper, and on participation in discussion.
79-171 Freshman Seminar: 19th and 20th Century Russia, Literature, Music, Art, Theatre
Intermittent: 9 units
This freshman seminar traces Imperial, Soviet and post-Soviet Russia in the 19th and 20th Centuries, a period famous for many cultural giants, like Pushkin, Dostoyevsky, and Brodsky in literature; Tchaikovsky, Prokofiev, and Shostakovich in music; Balanchine and Baryshnikov in dance; Repin and Shagall in painting; and Stanislavsky and Meyerhold in theatre. We will also examine the historical development of cultural institutions in Russia. The course includes secondary readings, primary documents, and films. In addition to seminar discussions, reading and written assignments, students will attend performances of the Pittsburgh Symphony and Pittsburgh Cultural Trust.

79-173 Freshman Seminar: Barack Obama and the History of Race in America
Intermittent: 9 units
Well before he was elected the forty-fourth President of the United States, Barack Obama challenged Americans to think anew about the history of race in this country. In this course, we will examine President Obama’s first biography and several of his key speeches as well as a recent history of the Civil Rights Movement. Our goal will be not only to probe the life and ideas of President Obama but to examine the larger history of race in America. Topics will include the geographic and temporal diversity of the Civil Rights Movement, the shifting meanings of “mixed-race,” race and American foreign policy, the history of racial inequality in housing, education, and employment, affirmative action, and race and immigration. This course will include two short papers (3-4 pages each) a student presentation, and a take-home final.

79-177 Freshman Seminar: The Social Impact of War
Intermittent: 9 units
Wars and their effects are a continuing aspect of the human condition. This course will introduce students to the manner in which war is conceptualized in modern western societies, using readings from philosophy, literature, history and the social sciences to examine how warriors, belligerent societies and cultures describe the benefits and costs of war. The course will primarily focus on the American experience of war in the twentieth and twenty-first century, from the Great War to the War on Terror, while also examining the Cold War and the antecedents to contemporary conflict.

79-198 Research Training History
Fall and Spring: 9 units
This course is part of a set of 100-level courses offered by H&SS departments as independent studies for second-semester freshmen, and first- or second-semester sophomores, in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. Prerequisites: restrictions: For H&SS students only; minimum cumulative GPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question. By permission of the relevant professor and the Director of Undergraduate Studies.

79-202 Flesh and Spirit: Early Modern Europe, 1400-1750
Intermittent: 9 units
This course examines European history from the Black Death to the French Revolution, a period known to history as the “early modern” period. That is, it marks a period in European history that was not quite medieval, and yet not quite modern. Many features of modern society, such as the nation-state, free-trade economies, religious pluralism, scientific rationalism, and secular culture trace their origins to the early modern era, yet the period was also marked by important continuities with the Middle Ages. During this course, we will explore how Europeans reimagined their world in its transition from the medieval to the modern. Topics to be considered will include the “renaissance” of the arts, the problems of religious reform, exploration and colonialism, the rise of science, and the expansion of the state. Through these developments, we will focus on Europeans’ changing notions of the human body, the body politic, and the natural world, as well as their re-interpretations of the proper relation between the human and the divine, the individual and the community, and the present and the past.

79-205 20th Century Europe
Intermittent: 9 units
This course surveys the history of Europe from 1900 to 2000 and beyond. While it covers major political trends and social/economic changes of the last century, it concentrates on the following themes: the extraordinary violence of the two World Wars — and their continuing impact on politics, society, and culture; social and political movements/changes of the 19th and 20th centuries; the rise and crisis of the European welfare state and of the European Union; reactions to US power and to “Americanization”; cultural and political controversies surrounding Islam and Muslims in Europe today.

79-207 Development of European Culture
Intermittent: 9 units
This course surveys the evolution of European culture from 1500-1950. It defines “culture” broadly to include not only philosophy, literature, and art but also science, manners, sexuality, morality, and religion. Lectures, readings, and discussions will introduce students to what Europeans thought and wrote about these questions. Readings will include no “history books” but only novels, plays, and memoirs. We will discuss these writings, on the one hand, as “literature,” that is, as examples of literary styles and themes and, on the other hand, as documents that reveal much about the philosophical and social conflicts that divided Europeans.

79-208 Europe’s Two Revolutions: Dynamics of Change in the 19th Century
Intermittent: 9 units
“Europe’s Two Revolutions” is a comparative history of Europe in the nineteenth century, focusing on France, Britain and Germany. The “Two Revolutions” title acknowledges that much of the history of Europe in this period can be understood as the legacies of the French Revolution of 1789-94, which unleashed new ideas about the nature of political life, and the Industrial Revolution, which brought a host of new social and economic problems to the continent. We approach the topic using a variety of sources including personal memoirs and eyewitness accounts, government reports, fictional accounts, speeches, and political writings of the time as well as more recent studies. We discuss the development of such important political and social movements as nationalism, feminism, conservatism and socialism, seeking to capture both similarities and differences in the ways these movements developed in the three countries. In addition to illuminating large trends in the nineteenth century, the course provides background for the study of twentieth-century European history, and for the history of other regions of the world that have been affected by both the revolutionary traditions born in France and processes of industrialization.

79-210 Identity, Statehood and Nationhood: Who is your Brother?
Intermittent: 9 units
This course offers an overview of the history of Islam as a divinely-inspired religion, and a system of thought, principles and goals, laws, obligations and values that strengthen communities, foster cooperation and dialogue and can lead to a new international order like the Organization of Islamic Conference (OIC).

79-211 Unity of Islam and Diversities in the Muslim World
Intermittent: 9 units
From the Mediterranean to the Pacific Ocean, Islam stretches as a system of belief and a total way of life encompassing peoples of different backgrounds and conditions and providing them with a sense of purpose and identity. Based on lectures and discussions that stress the unity of its creed since the 7th century AD and the extraordinary diversity of its communities throughout generations, this course offers a framework for the comparative analysis of religion and for the appreciation of the process of development of one unitary tradition within different societies.

79-212 China and Its Neighbors: Minorities, Conquerors and Tribute Bearer
Intermittent: 9 units
This course examines East Asian peoples on the peripheries of China and their interrelations from the time of Genghis Khan to the present, including Mongols, Manchus, Koreans, Tibetans, Muslim Turks of Central Asia, and ethnic groups of south China. It is, in part, a history of a civilization seen from its margins. We question the usual narrative of China’s uncomplicated absorption of its neighbors and conquerors, and pay attention, unconventionally, to voices of minority peoples. Besides ecology, war and diplomacy, we examine cultural conceptions and mutual influences. We also look for the emergence of a sense of identity among peoples in contact, including Han Chinese, especially at the onset of nationalism and industrialization. The course also looks at some Western views of the subcontinent’s peoples.
79-213 Nationalities and the New States of the Former USSR
Intermittent: 9 units
Until its collapse in 1991, the Soviet Union was a world superpower, incorporating within its borders the great landmass of Europe and Asia-modern Eurasia. Conditioned to view the Soviet state as a unified great power, many people have found it difficult to comprehend the rapid dissolution of this once mighty empire. Analysis of the nature of "ethnicity" and "nationality", as well as nationalism and policy toward the nationalities in the former Soviet Union, will form the background for analyzing the economic, social, political, environmental, military and foreign policy issues that have arisen within and among the new states today.

79-214 18th Century European History
Intermittent: 9 units
The goal of this course will be to examine, in both breadth and depth, the history of Europe between roughly 1715 (the death of Louis XVI) and 1815 (the fall of Napoleon). Broad themes to be covered include "old regime" Europe, European religiosity and secularism, the Enlightenment, the development of public opinion, the rise of Prussia, the industrial revolution in Britain and the continent, mercantilism, and trends in the arts. Students will be expected to attend lectures; participate in class discussion, write two exams, read and discuss a number of primary and secondary sources, submit weekly opinion papers, and complete a term paper on an 18th-century European topic.

79-220 Caribbean: Cultures and Histories
Intermittent: 9 units
This course is a general introduction to Caribbean histories and cultures, from before the arrival of Columbus to the present. Comprised of dozens of islands, the Caribbean has been a stage for the encounter of multiple empires and peoples-indigenous, European, African, and Asian. It remains an area of remarkable linguistic, religious, political, and ethnic diversity in the present. In this course we will explore some of the major themes that have characterized the region's many histories and cultures: the early cultural encounters of the period of conquest and colonization; the Atlantic slave trade, the emergence of plantation societies, and patterns of slave resistance; nationalism, imperialism and revolution; and the place of migration, popular religion and tourism in the contemporary Caribbean. Through the exploration of such topics as Negritude and Rastafari, and such media as music and film, this course will place the connections between politics and culture at the center of our encounter with the Caribbean's complex historical past.

79-221 Development and Democracy in Latin America
Intermittent: 9 units
This course will use readings, discussion, film, and music to explore development and democracy in Latin America. Beginning with the Mexican Revolution and ending with Hugo Chávez's on-going "Bolivarian Revolution" in Venezuela, we will approach development and democracy as historically contested concepts that gave rise to a diverse range of practices and institutions. Specific regions and topics covered include export economies in South America, immigration, industrialization, and populism in Argentina, socialism, dictatorship, and democratization in Chile; and indigenous people and drug wars in the Andes. This course is open to all students.

79-222 Between Revolutions: The Development of Modern Latin America
Intermittent: 9 units
When the Haitian Revolution began in 1789, everything south of the newly created United States was under European colonial rule, slavery was an established institution, and the Catholic Church held considerable power over the daily lives of people. However, when the Mexican Revolution began in 1910, Spanish and Portuguese colonialism had collapsed along with slavery, and the power of the church had greatly diminished. New societal institutions emerged that reflected novel ideas about the role of secular nation-states, "free market" economies, and the meanings of "civilization." This course will use scholarly writings, fiction, film, and video to analyze the profound changes that took place in Latin American society during and between these two important revolutions. We will pay attention to the lives of both elites as well as the "everyday" people who helped to shape the region's history.

79-224 Mayan America
Intermittent: 9 units
This course will explore the history and culture of the Maya from before the European conquest of the Americas to the present. After a survey of ancient Mayan society and of the European conquest of Mexico and Central America, we will consider the experience of the indigenous Maya under Spanish colonial rule and under the rule of Latin American nation-states in the nineteenth and twentieth centuries. Finally, we will cover the recent history of political conflict and military repression in Guatemala, the Zapatista uprising in southern Mexico, and increasing Mayan migration to the United States. Drawing upon the varied perspectives of archaeology, cultural anthropology, and social history, this course will explore several recurrent themes in Mayan America, such as: conquest, adaptation and resistance; indigenous political and communal organization; popular religion, prophecy and apocalypse; Mayan cultural and ethnic identity; "tradition" and "modernity"; state violence and human rights; and indigenous political and cultural mobilization at the local, national, and transnational levels.

79-225 West African History in Film
Intermittent: 9 units
West Africa is a vibrant, diverse, and rich region, which has had the largest influence demographically, culturally, socially, and linguistically on the Americas. This course will examine West Africa's history from the pre-colonial to the independence period. It will cover such topics as states vs. stateless societies, urbanization, trans-Saharan trade, Islamization, European interaction, the trans-Atlantic slave trade, colonialism, cash crops, missionaries, nationalism, and independence. Students will understand how this dynamic region changed over time as a result of internal factors, such as state formation, as well as external factors, interaction with Muslim and European traders. Students will also be exposed to the variety of sources used by historians to reconstruct West Africa's rich history. The course will use historical films by some of West Africa's most famous filmmakers, such as Ousman Sembene, to illustrate the diversity of the region.

79-226 Introduction to African History: Earliest Times to 1780
Intermittent: 9 units
A beginning point for this course will be the question: how do historians reconstruct history when few written sources are available? Breaking disciplinary boundaries, the course will draw on linguistics, "climateology," archaeology, and anthropology to reconstruct social, cultural, political, and economic processes in Africa before the arrival of Europeans and before the availability of written source materials. When written sources are available, the course will interrogate them to illuminate the changes that occurred in African societies during the early period of contact with Europeans. Lastly, by focusing on long-term processes, such as economic specialization, urbanization, and Islamization, the course will begin to put the slave trade in an African-centered perspective.

79-227 Introduction to African History: 1780-1994
Intermittent: 9 units
The goal of this course will be to examine, in both breadth and depth, the history of Africa between roughly 1780 (the fall of Napoleon). Broad themes to be covered include "old regime" Europe, European religiosity and secularism, the Enlightenment, the development of public opinion, the rise of Prussia, the industrial revolution in Britain and the continent, mercantilism, and trends in the arts. Students will be expected to attend lectures; participate in class discussion, write two exams, read and discuss a number of primary and secondary sources, submit weekly opinion papers, and complete a term paper on an 18th-century European topic.

79-230 European Interaction, the Transatlantic Slave Trade, Colonialism, Cash Crops, Missionaries, Nationalism, and Independence
Intermittent: 9 units
This course will explore the history and culture of the Atlantic world from the rise of the European slave trade in an African-centered perspective.

79-231 Political Economy of the Americas
Intermittent: 9 units
This course will explore the history and culture of the Atlantic world from the rise of the European slave trade in an African-centered perspective.
79-229 Origins of the Arab-Israeli Conflict, 1880-1948
Intermittent: 9 units
This course considers the historical origins and development of the contemporary Arab-Israeli conflict, beginning with the decline of the Ottoman Empire and the rise of Arab nationalism and Zionism in the late 19th century and emphasizing the period of the British Mandate over Palestine (1920-1948). Students will move beyond the textbooks to explore primary source documents, maps, media, biographies and historical testimony. For five weeks in the middle of the semester, students will immerse themselves in an extended role-playing exercise, "The Struggle for Palestine, 1936," an elaborate simulation game linked to Barnard College's "Reacting to the Past" program. Students portraying British examiners, specific Arab and Zionist characters and various journalists will recreate the activities of the 1936 Royal Commission which came to Palestine to investigate the causes of an Arab rebellion and Arab-Jewish strife. This historical reenactment experience constitutes an exciting pedagogical experiment and the opportunity for delving deeper into the topic material than regular coursework allows. All the role-playing will take place during regular class time, but students should be aware that they will need to devote considerable outside time for preparation and research. Outstanding attendance is also a requirement. Regular classroom activity resumes at the end of the five weeks. The goal of the course is for students to develop a nuanced understanding of the varying goals and priorities of all the actors in Mandate Palestine. Running throughout the course is the question, was peace ever possible? (Note: students who previously took 79-352, The Arab-Israeli Condition, may not enroll in 79-229).

79-230 Arab-Israeli Conflict and Peace Process since 1948
Intermittent: 9 units
This course begins in 1948 with the establishment of the State of Israel, the Palestinian dispersal and the first of many Arab-Israeli wars, and continues up to the present time. Emphasis is on primary source documents and other source material beyond the textbook such as maps, film, literature, media, autobiographies, and biographies. The examination of the many facets of the Arab-Israeli and Palestinian-Israel conflicts is accompanied by attention to the search for peace and its frustration. The semester culminates in a sustained role playing exercise simulating an Arab-Israeli peace conference. Is peace even possible?

79-231 American Foreign Policy 1945-Present
Intermittent: 9 units
This course provides an introduction to the study of U.S. foreign policy. Its main focus will be on problems and possibilities confronting the world during the Cold War as well as global political changes in the post-Cold War era and since 9/11. Important foreign policy strategies which will be discussed include the strategy of containment, NSC-68, the Eisenhower-Dulles "New Look," the Kennedy-Johnson "flexible response," "detente," the democratic peace, and contemporary approaches to combating global terror. Theoretical readings in history and political science will be used as analytic filters to assess both scholarly evaluations of American foreign policy and key historical episodes.

79-232 Britain and the Middle East
Intermittent: 9 units
This course examines the history of British involvement in the Middle East over the last 200 years. We will explore the strategies of British formal and informal influence in the region. We will start by focusing on the development of political, economic and cultural ties between Victorian Britain and the Ottoman Empire in the 19th Century. We will then study the British occupation of Egypt in 1881 as the beginning of a period of expansionism in the Middle East, follow the rise of British influence during WWI and the post-war Mandates in Palestine, Syria, Iraq and Iran, before tracing the decline of British influence in WWII, the 1948 War and the Suez Crisis of 1956. Throughout the course we will explore each topic through a range of primary and secondary material.

79-233 The United States and the Middle East since 1945
Intermittent: 9 units
This course begins by introducing students to the Middle Eastern priorities and policies which the US inherited from the British in the aftermath of the Second World War. The focus then moves to American interests and involvement in the Middle East from the Cold War through today, with special attention to recurring historical themes. Topics include the US role in the Arab-Israeli conflict and peace process, the role of oil, politics and conflicts in the Persian Gulf, and selected case studies of US political and military interventions in the Middle East. Reading assignments include a dual goal in mind: to understand American foreign policy interests in the Middle East, and to understand the forces and nuances endemic to the region itself. Emphasis will be on primary source documents.

79-235 Caribbean Cultures
Intermittent: 9 units
This course is designed to give students an overview of historical, political, social and economic developments in Africa. The course will begin with an examination of selected ancient African kingdoms. Pre-colonial African political systems will be discussed. That will be followed by discussion of Africa during the middle ages. Colonialism, nationalism, and post-colonial state will be covered. Vital issues such as democratization, conflict resolution, human rights, globalization, and Pan-Africanism will also be discussed.

79-236 Introduction to African Studies
Intermittent: 9 units
This course will explore slavery as it developed throughout the Atlantic basin, focusing on the Caribbean, North America and Brazil. Slave systems will be compared and various key concepts will be explored including, colonialism, emancipation, resistance, social stratification and cultural retentions.

79-240 The Development of American Culture
Intermittent: 9 units
This course considers the historical origins and development of the revolutionary and ante-bellum eras). (e.g., work, family, and religion) or chronological periods (e.g., the colonial, revolutionary, and ante-bellum eras).

79-243 African American Women's History
Intermittent: 9 units
The course explores African-American women's history from slavery to the present. We'll examine how gender and women figured in the creation of slavery in the Americas, slave women's experiences (reading a slave narrative), how freedom and emancipation were gendered, what battles feminist activists faced, the economic and cultural histories of black women, anti-lynching campaigns, labor campaigns, women's role in the Civil Rights Movement, beauty campaigns, among other topics.
79-244 Women in American History
Intermittent: 9 units
This course examines U.S. history through the eyes of women and gender. It begins in the colonial era (1600s) and runs chronologically to the present. It covers topics such as witchcraft, the story of Pocahontas, women's work, motherhood, slavery, and much more. We will look at the lives of individual women, as well as trends among women, paying attention to questions of race and class. At the same time, we will explore changing concepts of gender, meaning ideas about what women are or should be. Finally, the course asks: how different does American history look when we factor in women and gender?

79-246 Industrial America
Intermittent: 9 units
This course examines the transformation of America into an urban industrial society during the late 19th and 20th centuries. The transformation of work, culture, and politics will receive close attention, but the course will accent the impact of global migration on the creation of a multiethnic and multiracial nation. This course will also encourage students to probe certain similarities as well as profound differences between past and present responses to immigrants and immigration policies. In addition to regular classroom discussions of assigned readings, students will write a major research paper. This course is open to all students.

79-247 The Civil War Era 1848-1877
Intermittent: 9 units
This course examines America’s pivotal middle period, a period of rising sectional tensions, bloody civil war, slavery’s end, and protracted debates about the promise and limits of equality. The first third of the class traces the causes of the war, the middle third dwells on the devastating war itself, and the final third explores the aftermath of the war, when Americans clashed over how to reunite and over what the meaning of freedom for four million emancipated slaves ought to be. Sometimes known as “America’s unfinished revolution,” the Civil War continues to resonate in American society today, and the course concludes by considering current questions such as flying the confederate flag, slave reparations, and others.

79-249 20th Century U.S.
Intermittent: 9 units
The twentieth century marked the rise of the United States as a global power. By the end of the century, the United States had achieved economic, military, and political dominance. The United States also made great strides in expanding political and civil rights for workers, women, African-Americans, and gays and lesbians. This course explores the cultural implications of these developments on the generations of American people who came of age in the twentieth century. It assesses both the triumphs and tribulations of twentieth-century life. We will analyze the continuities, contradictions, and conflicts in American history, especially in regard to the nation’s twin pillars: democracy and capitalism. Special attention will be given to the evolving relationship among the state, the corporate sector, and ordinary people. Topics include: Progressivism, the Great Depression, World War II, the Cold War, Civil Rights, Vietnam, and the New Conservatism.

79-251 India/America: Democracy, Diversity, Development
Intermittent: 9 units
India and the United States, two of the world’s largest democracies, have long been interconnected—culturally, economically, and politically. From yoga and bhangra to outsourcing and nuclear politics, Indo-American relations have become increasingly important to both countries. This course will focus on connections between the United States and India in the twentieth century. Specific topics will include the Indian American struggle to gain American citizenship; American involvement in the Indian independence movement; the influence of Gandhian nonviolent civil disobedience on Dr. Martin Luther King, Jr.; and the American civil rights movement; Indo-American relations during the Cold War; American economic aid to India; outsourcing and other recent economic linkages; the history of Indian students in the United States; and cultural connections including food, dress, music, dance, and Bollywood/Hollywood.

79-252 Recent U.S. History 1945-Present
Intermittent: 9 units
This course will explore the social cultural and political history of America since World War II. Topics include: the dawn of the nuclear age, the cold war, the Korean and Vietnam wars, the civil rights movement, the women’s movement, counter culture, the energy crisis of the 1970s, the rise of environmentalism, the turn toward conservatism in the 1980s. We will use music, film, television, and literature as evidence of cultural change in American society during the past 50 years.

79-253 Native American History
Intermittent: 9 units
Native American history is currently one of the most exciting, dynamic, and contentious fields of inquiry into America’s past. This course explores the history of the Native Americans in North America from first contact with Europeans to the creation of the United States. It provides an overview of the major themes of Native American history supplemented by cases studies of specific tribal groups from the Mississippi Valley to Quebec. We will begin with a survey of the pre-contact occupation of North America and then examine the demographic, social, economic, cultural and political impact of European colonization between 1600-1800. Our primary focus will be Native Americans struggle to retain their cultures and autonomy while accommodating the reality of European settlement. Ultimately this course stresses the complexity of change in Native American societies and emphasizes the theme of Native peoples’ creative adaptations in the face of adversity. To uncover this story, we will read a selection of the latest scholarship.

79-254 The Jewish Diaspora in Latin America
Intermittent: 9 units
This course explores the history of the Jewish presence in Latin America and the relevance of the Latin American experience in shaping Jewish identity. We will survey the presence of Jews in Latin America from the time of the conquest to the present. Among the topics we will consider are: the Inquisition and crypto-Jews in Latin America; Jewish immigration in early nineteenth-century Latin America; relationships between Jews and non-Jews including other minority groups such as Arabs; relations between Ashkenazi and Sephardic Jews; Jewish cultural life and political activism in the context of the rise of modern-nation states, revolutions, military dictatorships and violence; antisemitism; and the influence of contemporary politics in Latin America on Jewish life.

79-255 Irish History
Intermittent: 9 units
This course surveys Irish history from the earliest human settlements until the present day, with emphasis on the period since the sixteenth century. Our main objective is to understand the sources of conflict in modern Ireland. In order to do that, however, we look at a number of topics such as the role of religion in Irish society; the causes of population growth, movement and decline; changing forms of protest; and the formation of rival myths of the Irish past and its meaning.

79-256 20th Century Germany
Intermittent: 9 units
This course will trace the evolution of German politics, society, and culture from 1914 through 2000. It will consider the causes and consequences of the huge upheavals and catastrophes that Germany went through in these decades: the First World War, political revolution, National Socialism, the Second World War, the Cold War division of Germany and Germany’s reunification. A major theme of the course will be Germans’ artistic responses (in visual arts, fiction, and film) to their country’s turmoil, crimes, and disasters in the 20th century. In addition to a survey history, students will read several novels, a memoir, eyewitness accounts, and one historical monograph. Writing requirements will include two 7-page essays on readings and a take-home final.

79-257 Germany and the Second World War
Intermittent: 9 units
This course examines the Second World War from the perspective of the country that was central to it in every way. The course will cover: Hitler’s ideology, war plans, and military strategy; the military/technological history of the War in Europe and North Africa; the role of the SS; the Holocaust; the occupation of Europe and Resistance movements; the political, social, and economic history of the Third Reich, including popular opinion, the German Resistance, and the use of slave labor in factories and on farms. Readings will include historical studies, a novel, and a memoir/diary. Students will watch four films about the war on Thursday evenings (these will be the only Thursday evening sessions of the course).
79-258 French History: From the Revolution to De Gaulle
Intermittent: 9 units
This survey course looks at French society and culture from the period after the French Revolution (roughly 1815) to the Nazi invasion of 1940. We first look at the multiple impacts of the Revolution on French society. We try to understand some of the lasting features of nineteenth and early-twentieth century France by studying the lives of different social groups including workers, peasants, and members of the elites. We follow the continuing problem of French political instability in the nineteenth century, trying to understand the deep rifts that divided different groups of French people from one another. We look at the devastating impacts of World War One and the Great Depression, and end with the collapse of France in 1940. Coursework is based on the use of works of fiction, film, personal memoirs, and art as well as historians’ writings. Written work includes papers and in class tests.

79-259 France During World War II
Intermittent: 9 units
This course surveys the history of French society, economy, and culture in the years 1939-1945 focusing on problems that the war and German occupation presented. Understanding life under the German Occupation and the collaborationist government in Vichy also requires us to look back at major political, social and economic conditions of the 1930s that divided the French people. We use film and personal memoirs as well as recent historical studies to recreate a sense of life during the war, and try to answer such questions as: What accounts for the French military collapse of 1940? Which groups of French men and women benefitted from collaboration with Germany? How did France’s collaboration in the Holocaust come about? We also consider how the French people have tried to come to terms with their wartime experience since the 1940s. This course is open to all students. Students can access films both through the video collection in Hunt Library and through evening screenings [days and times to be determined].

79-261 Chinese Culture and Society
Intermittent: 9 units
This course is an entry level survey to the culture and society in both historical and contemporary China. We will start the course by sampling various aspects of current Chinese culture and society, and then trace the historical background and cultural evolution during the long process of Chinese civilization. The following themes will be discussed: basic cultural concepts (qi, yin/yang, hexagrams, etc.) and their social implications; gender, marriage and family; ethnicities; tourism and environmental issues; practice of folk religions; as well as globalization and rise of consumerism. Our goal is to explore patterns of social and cultural transformations, as well as evaluate continuities and discontinuities in the historical development of China. We will mainly use scholarly works, but a few films will be considered in understanding various themes.

79-262 Modern China
Intermittent: 9 units
Assuming no prior familiarity with China or its culture, this course examines China’s continuous changes from the 1800s on, in its cultural traditions, identities, daily life, social relations, and self-perceptions, engendered by both internal initiatives and external contact. We look at how changes unfolded in mass movements and in individual lives, in statecraft thought and in societal practices. We examine the roles of such historical actors as the extended family, modern reformers, the state, the parties and ethnic groups. Participants learn to use primary sources in making historical observation and to critique some analytical approaches to modern Chinese history. Since we rely heavily on assigned readings, active class participation is essential in this course.

79-263 China’s Cultural Revolution
Intermittent: 6 units
This mini-course examines the Great Proletarian Cultural Revolution (1966-69) as a species of revolution, including its origins and its aftermath until Mao Zedong’s death in 1976. What were Mao’s goals in prompting this most famous of student uprisings? Why did he attack his fellow party leaders, and other authorities and symbols of China’s past? How did Chinese of various ages and statuses respond? What long-term effects did the movement have and how is it regarded in retrospect? To examine these issues we use memoirs, collections of documents and eyewitness accounts, a recent history, and visual material including film. No prerequisites.

79-264 China in the Age of Reform, 1978-Present
Intermittent: 6 units
This mini-course explores the social history of China’s dramatic emergence as an economic power in the past thirty years. We pay special attention to China’s export market, including the factories that supply Walmart and other foreign companies, and to the consumer revolution in Chinese cities. We also look at the Tiananmen June Fourth suppression of “Beijing Spring” in 1989, and whether the Communist Party is losing its authoritarian rule. We use various article collections and memoirs, as well as a number of films. No prerequisites.

79-265 Russian History: From the First to the Last Tsar
Intermittent: 9 units
This course covers a broad sweep of Russian history beginning with the first settlements of tribal nomads in the ninth century and ending with the fall of the 300-year-old Romanov dynasty in 1917. In our study of Russian colonization and state formation, we make the acquaintance of Mongol marauders, greedy princes, and peasant rebels, as well as Ivan the Terrible, Peter the Great, and the long succession reformers and reactionaries who occupied the Russian throne. We explore the development of a working class and the uprising of workers, peasants, and soldiers that ultimately brought down the Tsar.

79-266 Russian History: From Communism to Capitalism
Intermittent: 9 units
This course covers a broad sweep of Russian history from the socialist revolution in 1917 to the turmoil of the present. Spanning almost a century of upheaval and transformation, the course examines the October revolution, the ruthless power struggles of the 1920s, the triumph of Stalin, the costly industrialization and collectivization drives, the battle against fascism, and the “wild west” capitalism and collapse of the social welfare state in the present time. The course provides essential background for anyone interested in understanding the explosive, history-making events in the former Soviet Union.

79-267 The Soviet Union in World War II: Military, Political and Social History
Intermittent: 9 units
On June 22, 1941, Hitler invaded the Soviet Union. German troops quickly reached the hills above Moscow, surrounded Leningrad in the longest running siege in modern history, devastated the country’s economy, and slaughtered millions of Soviet civilians. Eventually, the Red Army came back from defeat to free the occupied territories and drive Hitler’s army back to Berlin. This course examines why and how the war was fought. Using history, films, poetry, veterans accounts, documentaries, and journalism, it surveys the rise of fascism, the Stalinist purges of the Red Army, the Hitler-Stalin pact of 1939, the Nazi massacres of Soviet Jews, peasants, and partisans, life on the home front, and the great battles of the war. Occasional Thursday evening film screenings. (There is no weekly Thursday evening class, although there is an occasional Thursday evening film, which is required.).

79-272 Iberian Encounters: Muslims, Christians and Jews in Spain
Intermittent: 9 units
In Medieval Spain, Islam, Judaism and Christianity coexisted in a situation distinguished by cooperation and exchange, as well as by friction, rivalry and violence. In this course, we shall explore the complexity of this historical encounter and its role in shaping questions of contemporary Spanish, Jewish and Muslim identity and national memory. We shall discuss topics such as: Inter-ethnic collaboration and violence; Jewish-Christian disputations; the exclusion and expulsion of religious and ethnic minorities; the historical memory of Spain’s multi-ethnic past, including the heritagization of the Muslim and Jewish past, and North African immigration in contemporary Spain. Historical documents, literary texts, film, musical traditions, as well as contemporary political and cultural debates, will be discussed to enhance familiarity with the topic. This course is open to all students.

79-274 19th and 20th Century Russia: Society, Art, Music and Theater
Intermittent: 9 units
This course will focus on the most significant historical events in 19th and 20th Century Russian societies, which influenced the development of Imperial, Soviet and post-Soviet culture and cultural institutions in Russia. Students will learn about famous giants of Russian literature, painting, music, and drama who gained global recognition. The course, which includes secondary readings, primary documents, and films, will allow students to achieve a critical understanding of contemporary Russia.
America has become a land of Islam. This is an important question to study for an appreciation of the dynamism of the US and the religion of Islam.

To a degree, however, it is both an old and new phenomenon. This course will explore the many facets of this. Islamic history and life, the process of its growth as well as the challenges and issues that American Muslims of different colours and backgrounds face.

What does it mean to be a leader in a globalized world? How can we change a violent world nonviolently? Mahatma Gandhi and Dr. Martin Luther King Jr. both grappled with these questions. They strove to wield power nonviolently, and succeeded in influencing not just their respective countries but also the global community. By the time he was assassinated in April 1968, Dr. King had long presented his approach to injustice as Gandhian. By exploring the relationship between Gandhi and King, as well as their individual lives and careers, this course will examine how ideas flow across national borders to create change in a globalized world.

Our usual conception of globalization foregrounds the contemporary West through the intersections of race, gender and social class. We will explore the socio-historical and present interactions of “the races” and the construction of racial identity in a variety of circumstances and cultures. We will also use film, music, literature, and concrete examples from world events to examine the asymmetrical power relations that have developed between populations living in close proximity. An important aspect of the course will be the deconstruction of whiteness, blackness, otherness, and the norm in the context of group interaction and the distribution of power.

The focus of this class will be on specific examples from North America, the Caribbean, and Latin America.

Social protest, when people come together to contest official policies or demand change, is a significant source of social transformation. From intense moments of popular uprising, like the 1999 Seattle protests against the WTO meetings or the water wars in Bolivia, to the continuous efforts of organized social movements like the Mothers of the Plaza de Mayo, the unified efforts of individuals working together carry limitless possibilities for drawing public attention and affecting the world in which we live. In this course, we will look at instances of social protest, investigating the forms it takes and the ways in which specific cultural and local histories are reflected and utilized in these spontaneous and organized expressions of collective will. Through readings and film we will pay attention to issues of organization and spontaneity, violence, and the use and definition of public spaces.

This course examines the tumultuous and paradoxical relationship between Latin America and the United States from the early 1800s to the present, with an emphasis on the Cold War era (1945-1989) when challenges to the power of the United States intensified along with U.S. efforts to maintain that power. We will study not only diplomatic relations, but also some of the cultural, economic, and environmental dimensions of the changing relationship. Course materials include scholarly readings, historical documents, film, music, and video. Participants will be expected to write short analytical essays, a final synthetic essay and participate regularly in discussions.

This course examines major themes in pre-colonial West African history, Islamization, urbanization, economic specialization, identity formation, interregional and trans-Atlantic trade, and European conquest. The focus of the course is on indigenous social processes and institutions and their evolution as West Africa becomes an important part of the wider Islamic and Atlantic worlds. Students will be introduced to a variety of interdisciplinary sources as we reconstruct a history which in some cases pre-dates and in others is not recorded in written sources.

Most Americans would identify slavery and colonialism when thinking of Africa’s relationship to the rest of the world. While these two institutions have been critically important in shaping Africa’s present condition and recent history, they only constitute a fraction of Africa’s past and its interaction with the wider world. This course traces globalization to ancient times and seeks to understand it from an African perspective.

Our usual conception of globalization foregrounds the contemporary West and on large-scale commercial structures and patterns. This course looks at how the local has “gone global” in China over a period of several centuries, focusing on how ordinary as well as elite Chinese have engaged with western-derived practices, symbols and ideologies, and transformed them for their own use. Besides considering the socio-economic impact of (19th century) opium smoking and (late 20th century) McDonald’s, our course examine efforts to “siliby” Christianity and Marxism in China, at local repercussions of the Cold War in the Taiwan straits, at the indigenization of environmental attitudes, and at the sense of Chineseness (Chinese transnationality) among people living outside China.

This course examines this shift through the lenses of history, philosophy, law, politics, and anthropology. Topics covered include: theories of justice; sovereignty; the universality of human rights; global inequality and poverty; trade and labor in the global economy; climate change; humanitarian intervention and just war; gender issues; post-conflict reconciliation and social reconstruction; as well as the emergence of transnational modes of governance. In addition to several short writing assignments, students will have the opportunity to carry out a research project on a relevant topic of their choice.

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79-299 Trafficking Persons: Children in a Global Context
Intermittent: 9 units
Many items circulate around the world, including persons. This course will examine the movement of children from one place to another, from child soldiers to sex workers, from adoptees to laborers; children form part of a global circulation that has complex personal, practical, and political consequences. We will take an anthropological and a historical perspective, comparing the various ways in which children circulate, the changes over time, and the impact of both cultural values and human rights policies on these movements. We will analyze the role of nation-states, international organizations, and NGO’s, along with the decisions individuals make about the well being of a child. Course material includes: anthropological studies, historical accounts, memoirs, and film.

79-300 History of American Public Policy
Intermittent: 9 units
This course will describe and analyze as aspects of the development of public policy in the United States from the colonial era to the present. For the purposes of this course, public policy will be defined as the making of rules and laws and their implementation by government either: 1) in response to the failure of private markets to reach desirable outcomes; or 2) in an attempt to achieve a particular normative vision of what society ought to be like. This course assumes that the public policy landscape is complex but still comprehensible given the proper set of analytical frameworks, and appropriate historical background. Particular emphasis will be placed on: changing views about the authority of the government to intervene in economic and social issues; the best way to balance individual and collective interests; and the variability within society of the life courses of individuals. Topics covered include: property rights, healthcare, the New Deal, civil rights, and drug policy.

79-303 Pittsburgh and the Transformation of Modern Urban America
Intermittent: 6 units
This course will focus on the transformations, both negative and positive, of the city of Pittsburgh and of the Pittsburgh region in the period from 1945 through the present. It will explore the following themes: the redevelopment of the city in the Pittsburgh Renaissances (I & II), the collapse of the steel industry and the development of a service economy, the city’s changing demography, suburban development, neighborhood decline and renewal, and environmental policy and change.

79-304 African Americans in Pittsburgh
Intermittent: 6 units
This course will examine the development of Pittsburgh’s African American community from the Great Depression and World War II through the era of deindustrialization during the late 20th and early 21st centuries. The course will emphasize not only the ways that a variety of external socioeconomic, political, and cultural forces shaped the political and cultural lives of black people in western Pennsylvania, but also the diverse strategies that African Americans devised to give meaning to their own lives and how these changed over time. Students will read both primary and secondary accounts of Pittsburgh’s African American history, write short analytical papers on specific topics or themes; and engage in regular classroom discussions of assigned readings.

79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967
Intermittent: 9 units
This course will examine juvenile delinquency in historical, sociocultural, and policy contexts during the past two centuries, and will focus mainly on the United States from the creation of the first juvenile reform school in 1825 to the Supreme Court’s famous decision in 1967 requiring that juvenile offenders receive select due process protections. Three themes will be emphasized: 1) changing legislative, judicial, corrective, and therapeutic attempts to define, punish, and rehabilitate “delinquent” youth; 2) behavior patterns of youths labeled “delinquent,” and how their behaviors changed over time; and 3), images of “delinquents,” especially as portrayed in films of the 1930s to 1960s.

79-306 Delinquency, Crime, and Juvenile Justice: 1970s to the Present
Intermittent: 9 units
This course examines juvenile delinquency in historical, sociocultural, and policy contexts since the U.S. Supreme Court’s In Re Gault decision in 1967. Readings are drawn from historical, sociological, psychological, literary, and journalistic accounts of juvenile delinquency and the juvenile justice system. We will also analyze the portrayal of delinquency, especially gang delinquency, as revealed in several feature films produced between the 1970s and the present (e.g., “Boyz N the Hood”).

79-307 Religion and Politics in the Middle East
Intermittent: 9 units
This course looks at the historic relationship among Islam, Judaism and Christianity and what they have to say about the nature of government, the state’s treatment of religious minorities, and relations among states. We will consider the impact of religion on domestic and foreign policy in selected Middle Eastern countries and communities, the role of religion in fueling conflicts, the phenomenon of religious fundamentalism, the challenge and opportunity this presents to the United States, and the potential for religion to help advance Middle East peace.

79-308 18th Century China Through Literature
Intermittent: 9 units
Run like a seminar, this course examines China’s most famous novel, the 18th century work by Cao Xueqin and Gao E, The Story of the Stone (aka Dream of Red Mansions, Hongloumeng), in a lively five-volume translation. This portrait of a family in decline offers a comprehensive view of urban social life and culture in the 18th century. We will add brief analytical readings on such key topics as authority in the family, gender, sexuality, folk religion, connoisseurship (of food, gardens, art, poetry), patronage and ethnic relations. In case some of the volumes go out of print, the seminar will read a one-volume version and parts of several other novels of the period. No prior knowledge of China is required, but you should enjoy reading! Limited enrollment, assigned papers, no exams.

79-309 20th Century China Through Film
Intermittent: 9 units
This course is about both film and history. It does not pretend to be a history of film, but it is both an introduction to some issues of modern Chinese history and an examination of how that history is treated in film, especially Chinese film of the past twenty years. We have selected some well-made films exploring some key issues of 20th century history, including several of Zhang Yimou’s works, documentaries made in the U.S. with Chinese assistance, and works by leading Taiwanese and Chinese American directors. In a few cases themes will be illustrated in excerpts. The readings consist of topical articles and book chapters, tied together by a general history of the period. The twice-a-week evening sessions are alternately for film viewing and discussions. Varied weekly assignments, some of them collaborative, will explore the social context and methodology of the films, developing critical skills in writing, observation, film, and historical imagination.

79-310 Religions of China
Intermittent: 9 units
How have Chinese addressed universal questions of personal meaning and survival, and of social connection and authority, with the help of religion? This course is interested in solutions elaborated over the centuries by Chinese religious and social thought, and by how they have come to shape the portrayal of Chinese religion in the West. We will begin with a discussion of religious and cultural traditions, including a consideration of the methodology for comparing religions. We will look at the textual canon, we are particularly interested in changing styles of ritual organization and practice. We examine mutual borrowing and competition among shamanism, ancestor worship, Confucianism, Buddhism, and Daoism, and the adaptation of each to varying societies and historical circumstances. Much of the material is in the form of original sources including descriptive accounts introduced by religious historians, and fiction. The last half of the course utilizes ethnography of Taiwan and Mainland China to account for the current flourishing of religion. It also considers whether Maoism is a sort of religion, and examines the fate of the Falungong in historical context.

79-311 Introduction to Anthropology
Intermittent: 9 units
Cultural anthropologists “make the strange familiar and the familiar strange,” attempting to understand the internal logic of cultures which might, at first glance, seem bizarre to us, while at the same time probing those aspects of our own society which might appear equally bizarre to outsiders. In doing so, anthropology makes us more aware of our own culturally-ingrained assumptions, while broadening our understanding of the possibilities and alternatives in human experience. This course will use ethnographic writings (descriptive accounts of particular cultures), as well as ethnographic films, to investigate the ways in which diverse societies structure family life, resolve conflict, construct gender relations, and organize subsistence, etc. We will assess the advantages and pitfalls of comparing cross-cultural data, analyze the workings of power within and between societies, and consider the politics of cultural representations. We will also discuss what the anthropologist’s relationship is to the people s/he studies, and the responsibilities inherent in that relationship. Throughout the course, students will learn the importance of an historical perspective on culture, looking at how and why societies change, and considering how we, as anthropologists, should assess these changes.
79-312 International Human Rights Institutions in Theory and Practice
Intermittent: 6 units
What role do international human rights institutions play in the protection and promotion of human rights? How and when did they emerge? To what extent are they (or could they be) effective? This mini course considers the historical development of the contemporary idea of human rights, the theoretical and ethical debates that accompanied the creation of international bodies designed to regulate and enforce them, and the promises and limitations embedded in the forms these have taken.
Finally, the course considers the effectiveness of these bodies in serving as vehicles or facilitators of forms of justice and in promoting the construction of just and peaceful societies.

79-313 Objects of Value
Intermittent: 9 units
Value is a universal human concern, one that is as much spiritual and aesthetic as it is material. However, objects of value are produced, exchanged, circulated, consumed and understood in profoundly different ways. This course is an introduction to the anthropological study of objects of value in a variety of cultural and historical contexts. We will begin by considering how anthropologists have understood the exchange of objects as gifts, both in societies in which the exchange of objects as commodities is non-existent or rare, and in societies in which gift exchanges persist alongside or even within a commercial economy. Then, after considering the forms of barter and exchange that occurred during European expansion, conquest and colonization, we will explore commodity exchange, commodity fetishism, and money, in both Western and non-Western contexts. Finally, we will consider how anthropologists have explored the contemporary politics of value, addressing such issues as: globalization; migration and the “dollarization” of economies in Latin America and Eastern Europe; local, national and global political and economic crisis; and the emergence of new kinds of commodities and money, such as the Euro.

79-314 The Politics and Culture of Memory
Intermittent: 9 units
How do societies remember? Memory is social, rather than simply individual, in scope. It is cultural, rather than purely psychological, in nature. Its significance is as political as it is personal. Traversing the globe and moving from the distant past to the immediate present, this course brings a comparative and anthropological perspective to the politics of cultural memory. It explores the wide variety of media through which memories are produced and conveyed from written histories to oral performances, from monuments and museums to film and photography. We will begin by surveying the different ways in which in the study of memory has been defined and will proceed to the close study of how memory works in several non-Western societies. Then we will explore the role of memory in the making of nations and families, in the formation of class and gender identities, and in recollecting and responding to the violence of slavery, colonialism, and genocide. Finally, we will consider the place and politics of memory in the writing of history by professional historians.

79-315 Hawaii: America's Pacific Island State
Intermittent: 9 units
This semester, we are focusing on Hawaii—a Pacific Island, an American state, and a popular tourist spot. Hawaii at once fills our imagination and occupies a strategic niche in United States policies. The story has not always been positive: we will take a historical perspective on the changes in Hawaii over the past two and a half centuries, and we will explore the culture of the islands. We will read accounts by "outsiders" and accounts by kama'aina, "children of the land," residents of Hawaii. We will also consider representations of the islands in media other than text, films, for instance, and visual arts. The goal is to explore the complexity of a place that is often stereotyped as "paradise," but exemplifies problems of conquest and commercialization, of ethnic groups and boundaries, of commercialization and globalization, and of identity politics and independence movements. Readings include anthropological texts, literature, and selected essays.

79-316 Photography the First 100 Years, 1839-1939
Intermittent: 9 units
Photography was announced to the world almost simultaneously in 1839, first in France and then a few months later in England. Accurate " likenesses" of people were available to the masses, and soon reproducible images of faraway places were intriguing to all. This course will explore the earliest image-makers Daguerre and Fox Talbot, the Civil War photographs organized by Matthew Brady, the introduction in 1886 of the Kodak by George Eastman, the socially important social documentary photography of Jacob Riis (How the Other Half Lives: Studies Among the Tenements of New York) and his successor, Lewis Hine, the Photo-Secession of Alfred Stieglitz, the Harlem Renaissance of James VanDerZee, the precisionist f64 photographers Ansel Adams, Imogen Cunningham, and Edward Weston, and a host of other important photographers who came before World War II. The class will be introduced to 19th century processes, such as the daguerreotype, tintype, and ambrotype, as well as albums prints, cyanotypes, and more. Two field trips will take place during class, one to The Frick Art & Historical Center and one to The Carnegie Museum of Art.

79-317 Art, Anthropology and Empire
Intermittent: 9 units
This seminar will explore the anthropology and history of aesthetic objects, as they travel from places considered "primitive" or "exotic," to others deemed " civilized" or " Western." First, we will consider twentieth-century anthropological attempts to develop ways of appreciating and understanding objects from other cultures, and in the process to reconsider the meaning of such terms as " art" and " aesthetics." Then we will discuss several topics in the history of empire and the "exotic" arts, including the conquest, colonization and appropriation of indigenous objects; the politics of display and the rise of museums and world fairs; the processes by which locally-produced art objects are transformed into commodities traded in international art markets; the effects of "exotic" art on such aesthetic movements as surrealism, etc.; and the appropriation of indigenous aesthetic styles by "Western" artists. Finally, we will consider attempts by formerly colonized populations to reclaim objects from museums, and to organize new museums, aesthetic styles, and forms of artistic production that challenge imperialism's persistent legacies.

79-318 Sustainable Social Change: History and Practice
Intermittent: 9 units
If you wanted to change the world, who would you ask for guidance? Gandhi, Martin Luther King, Mother Theresa, Rachel Carson, or Nelson Mandela? Perhaps you might write to Oxfam, Habitat for Humanity, or the Gates Foundation? Of course, these are but a tiny sample of the countless individuals and organizations that have worked to bring about change. But it is the history and practice of these efforts that will inform our understanding of today's challenges. In this interdisciplinary course, we will examine the history of efforts to create sustainable social change. We will look at the many ways that people have worked to bring about change, from targeted case studies, we will examine the successes and failures of notable leaders, past and present, who strove to address social problems nonviolently and to create sustainable improvements in fields such as education, healthcare, and human rights. In keeping with the example of the work that we will be studying, we will bring our questions and our findings out of the classroom. One integral part of this course will entail designing and implementing creative, student-driven lesson plans for high school students that communicate what we have learned about the history and practice of sustainable social change.

79-319 Bohemians and Other Cultural Rebels
Intermittent: 9 units
Explore the "bohemian" artists and countercultural figures that created new art forms and vibrant neighborhoods while sparking cultural and political revolutions across the globe. From the characters in La Bohème and Rent to the artists of Montparnasse and Greenwich Village, the Mods in London, the Beats in North Beach, the hippies in San Francisco, and the hipsters in Chicago, the figure of the bohemian has had a lasting place in our collective culture. Through readings, films, novels, and works of art, this interdisciplinary and transnational course will encourage students to explore the identities and meanings of, and conflicts among bohemian groups in the United States and Europe from the 19th century to the present. The discussion-based course will attempt to answer the following interrelated questions: How does one define bohemianism? How have bohemians defined themselves and how have outsiders’ views influenced this identity? How have bohemians and other countercultural groups influenced local, national and global politics, particularly in times of revolution and upheaval? What has been the relationship between bohemians and the middle class? And, how have bohemian enclaves influenced the cities in which they are located?
79-320 Women, Politics, and Protest
Intermittent: 9 units
This course examines the history of women’s rights agitation in the United States from the early nineteenth-century to the present. It investigates both well-known struggles for women’s equality—including the battles for women’s voting rights, an Equal Rights Amendment, and access to birth control—and also explores the history of lesser-known struggles for economic and racial justice. Because women often differed about what the most important issues facing their sex were, this course explores not only the issues that have united women, but also those that have divided them.

79-322 Family and Gender in Russian History
Intermittent: 9 units
Using film, novels, interviews, and historical sources, this course will explore the history of gender relations, the family, and women in Russia. Beginning in the late nineteenth century, we will examine family relations in both noble and peasant families, the laws governing marriage, divorce and children, legal restrictions on women’s freedom and education, and gender roles. We will look at the explosive changes of the Russian revolution and the radical experiments with free love and communal childrearing. We will trace the development of opportunities for women in the 1930s, the painful demographic impact of WWII, and the changing culture of the post war years. We will end by examining the difficulties that rural and urban families are currently facing in the transition to a market economy.

79-332 Family Gender and Sexuality in European History, 500-1800
Intermittent: 9 units
The medieval and early modern periods witnessed a transformation in the cultural and social understandings of gender. During this period, the mutable sexual categories of the pre-modern world evolved into the definitions of masculinity and femininity recognizable today. This course examines these changes in the understanding of gender and the family in Europe in the medieval and early modern periods, drawing upon readings in gender history, marriage and the family, and the history of sexuality. We will explore the ideal of Christian marriage and family and examine how the “ideal” compared to the reality on such issues as marriage practices, family, gender roles, and sexuality. We will also explore the fashioning of female and masculine gender norms and the construction of the male and female sense of self over time. In the process, we will examine the larger historiographical issue of the use of gender as a tool of historical analysis.

79-335 Art and Religion
Intermittent: 9 units
The Art and Religion course will explore several major artistic manifestations prompted by religious beliefs during the history of art. Emphasis will be on the arts; however, general historical, eschatological, and philosophical explanations will be attempted. Major religions will be brought to discussion in one or several of their artistic manifestations.

79-336 History of German Cinema History of Modern Germany through its Cinema
Intermittent: 9 units
This course offers both a history of German cinema and a survey of 20th-century Germany as seen through German films. As film history, the course introduces students to movies spanning the silent era, Nazi films, the West German New Wave, socialist cinema, and post-unification movies. We will consider stylistic and technical trends as well as dramatic content. As a course in German history, the course sets major movies from each era against a backdrop of political and social developments. We will also analyze the portrayal of World War II and the Third Reich in films made after 1945. We will view c. 20 films, most in class, several in the evening. Readings will include works on the history of German film and a textbook on 20th-century German history. Writing will consist of three 5-page essays and one 8-10 page paper.

79-327 History of the American Working Class
Intermittent: 9 units
This course will examine the transformation of the American working class from its preindustrial origins to the recent period of deindustrialization. It will emphasize the changing relationship between owners, managers, and workers, the role of the state, and the impact of gender, race, and ethnicity. More specifically, this course will not only analyze the factors that facilitated and/or impeded working class solidarity, but also assess the impact of the working class upon the development of American history.

79-329 History of Feminist Theory
Intermittent: 9 units
This course is a historical look at feminist theory as it has been developed and/or applied in the United States. Beginning with the Enlightenment and Mary Wollstonecraft, and moving chronologically to the present, we will look at how women have thought about women’s condition. We will look at a broad range of historical female theorists—including Margaret Fuller, Emma Goldman, Anna Julia Cooper, and Zora Neale Hurston, to name a few—along with a broad range of recent theorists, from Michel Foucault to Judith Butler.

79-330 Medicine and Society
Intermittent: 9 units
This course examines the history of American medicine, public health, medical education, disease patterns, and patients’ experiences of illness from the colonial period to the present. Students read the voices of historical actors, including physicians, patients, policy makers, and researchers. In analyzing these voices, students will learn what was at stake for different sets of actors as they confronted diseases and struggled to explain and cure them.

79-331 Body Politics: Women and Health in America
Intermittent: 9 units
Women’s bodies have been the sites of long-standing, and sometimes deadly, political battles. This course takes a topical approach to the history of American women’s health in the nineteenth and twentieth centuries in order to understand why women’s bodies have been such heated sites of struggle. It covers topics such as the history of contraception, abortion, menstruation, sexuality, female anatomy, rape, domestic abuse, menopause, pregnancy, and childbirth. It explores how American culture has constructed these issues over time, while also examining women’s organizing around them. This course is open to all students.

79-332 Medical Anthropology
Intermittent: 9 units
This course will explore the ways in which different cultures conceptualize the body and its relation to the physical, social, and supernatural environments. We will examine how illness and its causes are understood, investigating not only the beliefs and practices surrounding healing, but also the social position and training of the healers themselves. In order to understand the context of healing in cross-cultural perspective, we will problematize the boundaries between medicine and other arenas of social life: religion, politics, law, economics, etc. We will investigate issues of medical efficacy (what “works?”) by asking who or what is being healed in different kinds of medical practices, and we will consider the ways in which power and social control are exerted through medical discourses of various sorts. Finally, we will examine the history of medical anthropology from its “clinical” origins in international development, through anthropological critiques of clinical perspectives, to attempts to fuse clinical and critical approaches. Throughout the course, Western medical practice will be analyzed as one of many forms of ethnomedicine and ethnopyschology.

79-333 Biology and Society: Evolution Animal Experimentation and Eugenics
Intermittent: 9 units
This course focuses on the relationship between biology and society in Britain, Continental Europe, and the United States in the 19th and early 20th centuries. We will examine the ways that biology and society evolved together during this period, and became increasingly reliant on one another in the process. The first part of the course will cover the development of evolutionary thought, especially Darwin’s theory of evolution by natural selection. In order to gain a full appreciation of Darwin’s accomplishments, we will examine the scientific, religious, political, and philosophical ideas that influenced him. We will also explore the influence of Darwin’s theory in all realms of society. The second part of the course will be devoted to the rise of experimentalism in biology. As part of this unit, we will explore the early history of genetics and its social application in the form of eugenics. The course will culminate with an analysis of the scientific and moral debates about animal experimentation that took place in the mid-19th century as Western conceptions of humanity’s place in nature were changing dramatically.
79-334 Law, Ethics, and the Life Sciences
Intermittent: 9 units
This course examines how advances in genetics, neuroscience, and other life sciences have enhanced, undermined, and sometimes brought about the reconfiguration of our conceptions of justice, fairness, ethics, property, responsibility, free will, community, public/private boundaries, identity, and even humanity. We will read a variety of primary and secondary sources that explore these issues from the perspectives of history, ethics, law, public policy, and science and technology studies. At the end of the day, though, this course is about real people (whether they be scientists, ethnists, patients, activists, lawyers, politicians, or ordinary citizens), and we will try as much as possible to focus on the human stories that animate historical and theoretical debates.

79-335 Drug Use and Drug Policy
Intermittent: 9 units
This course examines the use of psychoactive drugs in American history, as well as medical, scientific, and policy responses to that use. Drugs we will consider include alcohol, heroin, marijuana, tobacco, and cocaine. We will examine changing theories of addiction, ethnographic studies of drug using groups and the cultural meanings of drug use. We will also consider drugs as commodities in international trafficking. Although the primary focus is on the U.S., we will look at policy approaches to drug use in other countries as well, to put American drug policy in a comparative perspective.

79-338 Education and Social Reform
Intermittent: 9 units
In this course, we examine several themes in the history of American education in the 17th to 21st centuries. While schooling is a central focus, we also study the evolving educational roles of other institutions, e.g., families, churches, workplaces, peer groups. Finally, we try to shed historical light on several contemporary educational controversies, such as desegregation, bilingual education, homework, sex education, religion in the schools, textbook bias, school vouchers, charter schools, and No Child Left Behind.

79-339 Juvenile Delinquency Through Film
Intermittent: 6 units
This course is not open to students who have previously taken 79-305 or 79-306. How have American films portrayed juvenile delinquency and the juvenile justice system? What does filmmakers’ portrayal of juvenile delinquency tell us about American culture and society? Do films vividly capture or badly distort the “realities” of crime and the operations of the justice system? This mini-course uses feature and documentary films (to be viewed in advance of class) from the 1910s to the 1990s, as well as select autobiographical, journalistic, and scholarly readings, to explore these issues. The course will be run as a colloquium, with students playing leadership roles in guiding and guiding class discussions. There will be both a mid-term and a final exam. Two classes will be reserved for viewing and discussion of student-selected films.

79-340 Gender, Race, and American Sport: Historical and Contemporary Perspectives
Intermittent: 9 units
This course will examine how gender and race have shaped organized sports during the past century, especially in the U.S. A variety of competitive levels will be examined, although the focus will be on collegiate, amateur, and professional sports.

79-341 The Cold War in Documents and Film
Intermittent: 9 units
[Note: students who have already taken this course under its former number 79-351 and former title, The Cold War in Documents and Film, may not enroll.] This course is based on use of historical documents and films to study problems which reshaped the world during and after the Cold War. We will examine how documentary and feature films depicted the most important events of the Cold War, such as the Korean War, the construction of the Berlin Wall, the Cuban missile crisis, and others. In addition to films, sources will include documents, lectures and readings.

79-342 Introduction to Science and Technology Studies
Intermittent: 9 units
Introduction to Science and Technology Studies introduces students to an exciting field at the intersection of history, sociology, and anthropology. It asks students to think critically about how knowledge is produced and applied. It explores how tools and innovations are developed and what uses they are put to. It examines the scientific, technological, social, and cultural meanings of scientific findings and technological innovations. Rather than treating new technologies as objects whose utility is self-evident, the course frames technologies as systems involving objects, their use, the development and transfer of knowledge about their uses, and the social spaces that technologies inhabit. The course also examines the laboratory and its relation to the world outside—including ways we have transformed our world in light of laboratory findings. Americans have enormous faith in the power of scientific and technological advance to offer straightforward solutions to complex problems. This course aims to develop the kinds of judgment that enable us as professionals and as citizens to make more sophisticated assessments of the potentials of science and technology.

79-343 History of American Urban Life
Intermittent: 9 units
This course examines the development of urban America during the 19th and 20th centuries. It explores the evolution of urban structure; the development and impact of urban technologies (transportation, water/wastewater, energy and communications); ethnic and racial change and class conflict in the city; and political and policy issues. It discusses alterations in American city structure and form through the walking city, the networked city, and the development of the suburbs.

79-345 The Roots of Rock and Roll, 1870-1970
Intermittent: 9 units
This large-lecture course spans the century from 1870 to 1970 and spends 8 weeks on “roots” music – slave songs, Anglo-Appalachian ballads, ragtime, Tin Pan Alley, and 1920s-1930s blues and country – before you’ll hear a single electric guitar. After studying Bessie Smith, Woody Guthrie, Lead Belly, Hank Williams, and other early artists, we’ll spend the last 7 weeks on revolutionaries like Chuck Berry, Bob Dylan, Jimi Hendrix, and Janis Joplin. The format is informal lecture and discussion on Tues/Thurs afternoons, plus a required film screening every Wednesday evening, 6:30-9:20pm. Assignments include reading 2-3 books and many articles (including some cultural theory), weekly music listening, four short papers, occasional quizzes, and a final project.

79-346 American Political Humor from Mark Twain to the Daily Show
Intermittent: 9 units
This course takes a cultural approach to U.S. history since the Civil War, as seen by the nation’s most astute and influential critics: its political humorists. Besides immortals like Mark Twain and contemporary novelist Don DeLillo, we will (re)discover the satirical yet hilarious voices of H.L. Mencken, Will Rogers, Dorothy Parker, Walt "Pogo" Kelly, Richard Pryor, Fran Lebowitz, and others through essays, novels, recordings and films. Throughout the term, we will collaborate in defining terms and learning a vocabulary we can use to discuss and write analytically about ephemeral, topical critiques that make us laugh in order to make us think. How does “humor” differ from “comedy” or from “jokes”? Beyond lampooning government or elections, what makes humor “political”? What are the relationships between politics and art? What can political humor reveal that we might not “get” by any other means? At its sharpest edges, humor addresses issues of class, gender and race in American life, and provokes alternative thinking about mass culture, consumerism, and conformity. To provide context and analytical resources for these themes, we will also read historical studies and relevant theories by Sigmund Freud, Luigi Pirandello, and Mary Douglas. Assignments include four analytical essays, entries in a collaborative online glossary, a brief oral report, and occasional short quizzes on assigned readings.

79-348 Abraham Lincoln at 200: From 1809-2009
Intermittent: 9 units
As America continues celebrating the bicentennial of Abraham Lincoln’s birth, this course will explore both his historical importance and his changing status as an American icon. We will not only learn about Lincoln’s life, we will address controversies about him (such as his attitudes and methods regarding slavery and racism). Readings will include a short biography, a book about his friendship with Frederick Douglass, and Lincoln’s own speeches and writings. His skills as a precise and succinct writer will be an ongoing focus; hence, assignments will emphasize the drafting, revising, and polishing of short essays, rather than the memorization of facts.
This course explores the attitudes and actions of the Holocaust perpetrators, the bystanders, and the victims. Moreover, it discusses what implications and issues arise from this watershed event in World and Jewish history. It descends into the world of the Holocaust not only by reading about events and viewing several films, but also by meeting Holocaust survivors.

79-351 The Ballet Russe (The Russian Ballet) and its Artists
Intermittent: 9 units
The leading artistic position of the French Avant-Garde in the 1910’s and 1920’s was partly predicated on the assembly, meeting, collaboration and cross-influence of artists from all over Europe. The visual artists, musicians and performers brought with them specific aspects of their native heritage, therefore contributing to the enrichment of the general cultural scene. Paris with its cultural focal point the Ballets Russe became a melting pot of creativity.

79-352 Christendom Divided: The Protestant and Catholic Reformation 1450-1650
Intermittent: 9 units
At the dawn of the sixteenth century, western Europeans still shared a common religion and identity as members of the Roman Catholic Church. Within less than two decades, this uniformity began to crumble, and the very fabric of western culture was irrevocably altered. By 1550, Europe was splintered into various conflicting churches, confessions, sects, and factions, each with its own set of truths and its own plan for reforming the church and society at large. This period of rapid and unprecedented change in western history is commonly known as the Reformation. Though this term has traditionally referred to the birth of Protestantism, it also encompasses the simultaneous renewal and reform that occurred within Roman Catholicism.

This course will survey the Reformations of the sixteenth century, both Protestant and Catholic, examining the causes of the Reformation, the dynamics of reform, and its significance for western society and culture. In the process, we will analyze such on-going problems as religious persecution and the accommodation of dissent, the relationship between religion and politics, and the interactions between ideology and political, social, and economic factors in the process of historical change.

79-353 Religious Identities and Religious Conflicts in 19th Century Europe
Intermittent: 9 units
This course explores the place of religious identity and conflict in the history of European society from the French Revolution to World War I. We study the many ways that individuals constructed and used their religious identities to approach problems of public life. We examine continuities and changes in religious institutions as well as conflicts between churches and states. The course shows that, far from declining in importance during the process, we will analyze such on-going problems as religious persecution and the accommodation of dissent, the relationship between religion and politics, and the interactions between ideology and political, social, and economic factors in the process of historical change.

79-354 The Holocaust in Historical Perspective
Intermittent: 9 units
What does it mean to say that someone does (or does not) have rights of citizenship? How are ideas of the rights and responsibilities of citizens different in nations across the world? In what ways does the lived practice of being a citizen differ from ideal notions? In this course, we look at the history and development of the idea of citizenship in a cross-cultural perspective, focusing on the global interconnections that influence the forms that citizenship takes.

We will examine the roots of political citizenship in Western society, and compare these to other foundational notions of state-subject relationships (such as in the Ancient Near East and Ancient China). We then consider the formation of European nation-states and the emergence of modern citizenships. In the second half of the course, we use examples from across the world to think about how subjects experience citizenship in particular ways, paying special attention to the margins and borders of citizenship (refugees, migrants, internally displaced peoples, cultural minorities, economically disadvantaged communities, etc.). The class is discussion-based, and students will complete short assignments and a final essay. This course is open to all students.

79-355 World Citizenship
Intermittent: 9 units
Come and explore the rich musical heritage of Black America. This course will survey the music of Black America beginning with the African legacy and continuing through the music of the Twentieth Century.

Class sessions will involve discussions, listening, viewing of films, and reports by students on topics of individual interest. Discussions will involve, historical, cultural and political perspective, as well as the music and composers themselves. Lecturing will be at a minimum. Innovative testing in quiz show format will be used. No prerequisites required. Open to upper level undergraduate students.

79-356 The Islanders: Identity and Inequality in the Pacific
Intermittent: 6 units
Those outsiders—who treated the islands as either unoccupied or peopled by savages, ripe for exploitation, prime sites for military bases, and ideal locations for high-cost resorts. Our focus will be on the islands the US entered, but we will also consider comparative cases. Readings include anthropological and historical accounts; films will also form a basis for class discussion.

79-357 Special Topics: History of Black American Music
Intermittent: 6 units
For centuries, European powers invaded, intruded on, and took over islands in the Pacific. Then the islanders began to protest, to rebel, and to claim sovereignty over their own affairs. In the course, we will talk about “outsiders” who settled the islands and the evolving movements against those outsiders—who treated the islands as either unoccupied or peopled by savages, ripe for exploitation, prime sites for military bases, and ideal locations for high-cost resorts. Our focus will be on the islands the US entered, but we will also consider comparative cases. Readings include anthropological and historical accounts; films will also form a basis for class discussion.

79-358 Claiming the Pacific: Pacific Islander Struggles for Survival
Intermittent: 6 units
Life on the big ball is not at all what it used to be, nor at all what it will be. The instability and deterioration of past societies that resulted from miscomprehending and misusing natural and human resources will be briefly surveyed. Throughout most of the semester, we will discuss the origins, implementation, effects, and prospects of intellectual, regulatory, and technological inventions for greening the blue marble. We will read widely in fields useful for navigating Spaceship Earth — agricultural science, earth and planetary sciences, ecology, economics, engineering, environmental law, and regional planning, among others. This course is open to all students.

79-359 Sustainable Innovations: Ideas, Policies & Technologies to Make a Better Planet
Intermittent: 9 units
The leading artistic position of the French Avant-Garde in the 1910’s and 1920’s was partly predicated on the assembly, meeting, collaboration and cross-influence of artists from all over Europe. The visual artists, musicians and performers brought with them specific aspects of their native heritage, therefore contributing to the enrichment of the general cultural scene. Paris with its cultural focal point the Ballets Russe became a melting pot of creativity.

79-360 Historical Evidence and Interpretation
Fall and Spring: 12 units
Historical Evidence and Interpretation acquaints students with how historians practice their craft in interpreting events from the past. The emphasis is on learning to supplement standard secondary accounts of an event with primary sources such as memoirs, government documents, speeches, literary sources, news accounts, music, maps, and images. The goal is for students to develop a familiarity with the skills required to identify a research topic, find and work with many kinds of sources, create a strong thesis statement, design a persuasive paper, and produce a properly formatted and well-written research paper. Please note that coursework is appropriate for a 12 unit course.
79-361 Protest, Propaganda and the Public Sphere, 1500-1800
Intermittent: 9 units
The advent of the printing press created unprecedented opportunities for the spread of new ideas in early modern Europe. Throughout the period, Europeans harnessed the power of print to mobilize opinion and effect change. This new print culture, combined with powerful images and a lively mix of gossip, rumor, and popular song, played a pivotal role in the revolutionary changes of this dynamic age. This course explores the popular protests of the early modern era through the propaganda that fueled them: the pamphlets, ballads, rumors, and cartoons that spread the message of change and galvanized popular support. In particular, the course will focus on the role of such propaganda in three critical moments of early modern European history: the German Reformation, the English Civil War, and the French Revolution. In the process, we will explore such historical problems as the cultural consequences of the coming of the book, the impact of censorship, the emergence of the "public sphere," and the rise of popular politics and public opinion as recognized forces in European political life.

79-362 Law and Disorder in Early Modern Europe, 1400-1800
Intermittent: 9 units
The growth of legal institutions and their expanding use in enforcing "social discipline" marked an important -- and often controversial -- development in consolidating the political authority of the emerging states of the early modern era. This seminar will examine this process, looking at early modern European legal institutions and their role in defining and enforcing societal norms of conduct and belief. We will examine how the shifting definitions of "crime" within the period reflected prevailing societal attitudes and anxieties toward perceived acts of deviance and persons on the margins of society. In addition to the workings of governmental and legal institutions, we will also explore the ways in which early modern communities used informal social and economic sanctions to police communal standards, sometimes against the will of the authorities. Assigned readings will address such topics as the early modern European civil, criminal, and ecclesiastical court systems, investigation and punishment of crime, criminalization of social deviance (witches, vagrants, religious minorities and other outcasts), and the legal enforcement of sexual morality and gender roles.

79-363 The Rise of Modern Golf, 1860 to the Present
Intermittent: 9 units
An aristocratic pastime or the people's game? This course will examine the historical emergence of golf as both an amateur and professional sport and as a popular leisure activity between 1860 — when Prestwick Golf Club in Scotland hosted the first (British) Open — and the present. Discussions will center on a wide variety of historical, sociological, literary, legal, and mass media sources, all designed to illuminate broader themes in social and cultural history. All students are welcome to take the course, whether or not they play the game of golf. However, if you think that St. Andrews is the Vatican's summer home or that a mashie niblick is a side dish at KFC, you may want to reconsider.

79-368 Poverty, Charity, and Welfare
Intermittent: 9 units
This course explores continuities and changes in ways that people have thought about and acted upon problems of human poverty. Although the major focus will be on Western Europe, students will have the opportunity to explore other societies and cultures. We discuss ways that poverty was conceived of and treated in medieval society; transformations in these views and policies during the Protestant and Catholic Reformations; the impacts of industrialization on the poor; and the development of modern welfare states. We ask such questions as: What have been the major causes of poverty? How did organized programs for the poor develop in the West? How have the poor been thought about and represented in art and literature? What have been the main differences between religiously inspired and secular programs of aid to the poor? What accounts for the growth of "welfare states" in the twentieth century? Coursework includes readings from primary and secondary sources, participation in class discussions, in-class test, and a short research paper.

79-371 African American Urban History
Intermittent: 9 units
This course will explore selected themes in the development of African American urban history from its colonial beginnings through the era of Barack Obama during the early 21st century. While giving primary attention to the growth of black urban communities on the ground in major U.S. cities, the course will open and close on a global note. Students will learn that the dominant impact of the English-speaking world on black urban life was a foregone conclusion. Spanish, Dutch, French, and Indigenous peoples also shaped the black urban experience in North America. In addition to weekly classroom discussions of assigned readings, students will select a key theme in the development of African American urban life and, based upon a mix of secondary and primary accounts, write their own original essay on the subject.

79-372 Perspectives on the Urban Environment
Intermittent: 9 units
This course will explore the interaction of cities, technology and the natural environment over time. In doing so it will consider major issues confronting cities today including landscape and site changes; water supply, wastewater disposal and flooding; solid waste disposal; transportation and suburbanization; energy changes; and the impact of deindustrialization. These themes will be approached through a combination of class discussions, lectures, and visiting speakers. Class participation is expected, and will comprise a portion of the grade. In addition to required texts, readings will be distributed on Blackboard.

79-374 American Environmental History: Critical Issues
Intermittent: 9 units
This course explores critical issues in the history of the American environment during the last three centuries. Among the specific topics to be covered are changing attitudes toward nature; forms of rural and urban development and environmental effects; the impacts of technology and industrialism; the conservation and environmental movements; and environmental problems and prospects today.

79-375 China’s Environmental Crisis
Intermittent: 9 units
In the context of China’s changing ecology, this course explores whether and how sustainable development has been, is being, and might be pursued by its vast population and political leadership. Without neglecting culture—e.g., Confucian, Daoist, Buddhist and Altaic (steppe) views of ideal human/environment interaction—we trace historical demographic patterns and their effects on China’s fauna and flora, and investigate past government efforts at water control, migration, new crop introduction, natural disasters, etc. Over half of the course concerns the People’s Republic (1949—), paying special attention to birth control policies, the steppe reclamation, the Three Gorges dam, industrial growth, pollution scandals, tourism and environmental policy. We work mostly by discussion, centering on materials read in advance by class members.

79-376 Nationalism and Ethnicity
Intermittent: 9 units
Nationalism and ethnicity are overlapping concepts that offer rich material for research and rethinking of modern change. Using case studies and select theories, this course asks where nations and ethnic groups come from, what determines their nature, behavior and evolution, and how nationality and ethnicity are related. Our cases range over the globe and back several centuries, but our most common reference will be to the problems of nationalism and ethnicity in mainland China and Taiwan, from imperial to socialist times. Students familiarize themselves with a single region or group, not necessarily in East Asia, and with the instructor’s guidance prepare a term paper in a comparative vein.

79-377 Food, Culture, and Power: A History of Eating
Intermittent: 9 units
This course will take participants on excursions into the histories and cultures of foodways around the world. We will read a range of historical and anthropological perspectives on the production and consumption of food. However, the course does not claim to be encyclopedic in its coverage, but rather will focus on a select number of examples intended to provoke thinking about the relationship between food and power in modern human societies. In addition to reading about exotic foodways in far-flung places, we will also meet people in Pittsburgh’s food scene. Please note that this course fills a requirement for the major in Global Studies. There are no prerequisites, but participants are required to do all reading, participate in discussions, and produce an independent research paper.
This page includes course descriptions for various courses at Carnegie Mellon University. Here are some highlights:

- **79-379 Extreme Ethnography**: This course examines the role of ethnographers in extreme contexts such as cultural dislocation, violence, and death. Students are expected to have a background in anthropology.

- **79-380 Ethnographic Methods**: Students will learn about ethnographic methodological approaches and how to apply them in fieldwork and writing. This course involves reading and writing ethnographic fieldnotes and analyzing them.

- **79-381 Energy, Environment, Globalization in the Americas**: This course explores the relationship between energy systems and environmental change. Students will engage in research and writing projects related to energy and environmental issues.

- **79-382 History of Biomedical Research**: This course offers an overview of biomedical research from the eighteenth to the twentieth centuries, focusing on the development of research infrastructure and the role of scientific knowledge.

- **79-383 Epidemic Disease and Public Health**: This course examines the historical and current impact of infectious diseases on public health, emphasizing the role of scientific and cultural factors.

- **79-384 History of Modern Warfare**: This course delves into the history of warfare from ancient times to the modern era, considering the evolution of military technology and its impact on society.

- **79-385 The Making of the African Diaspora**: This course investigates the transatlantic slave trade and its impact on the African Diaspora, focusing on the processes of diaspora formation and cultural retention.

- **79-386 Entrepreneurs in Africa, Past, Present and Future**: This course examines the role of entrepreneurship in Africa, considering historical and contemporary contexts.

- **79-387 Stalin and Stalinism**: This course examines the life and legacy of Joseph Stalin, exploring his role in the construction of a totalitarian regime in the Soviet Union.

- **79-388 Nazi Germany**: This course examines the Nazi regime's impact on German society and culture, focusing on the Holocaust and the rise of National Socialism.

- **79-389 Stalin and Stalinism**: This course continues the exploration of Stalin's political and social impact on the Soviet Union.

- **79-390 Nazi Germany**: This course builds on the previous course, focusing on the socio-political effects of National Socialism and the Holocaust.

- **79-391 Comparative Postwar Societies**: This course compares and contrasts the social, cultural, and political development of various countries in the postwar era, considering the impact of World War II and the Cold War.

- **79-392 History of Modern Warfare**: This course examines the evolution of warfare, focusing on technological developments and their impact on military strategy and tactics.

These courses cover a wide range of topics, from ethnographic methods to the history of modern warfare, providing students with a comprehensive understanding of various disciplines.
97-394 Revitalizing Pittsburgh: Malls, Mills and Medical Centers
Intermittent: 9 units
This course examines strategies for urban redevelopment and economic revitalization in the US since World War II. We will be examining the specific context of Pittsburgh with special focus on critical contemporary issues such as the role of medical centers, universities, technology, retail outlets, and gas drilling. We will be doing critical readings and primary research as we explore both the problems and possibilities of economic urban reinvention in the last half century.

97-395 The Arts in Pittsburgh
Intermittent: 9 units
This course will examine the arts in Pittsburgh, both historically and in the present. We will focus especially on art exhibits and musical events scheduled by the city’s museums and concert halls during the semester. The “curriculum” will derive from the artistic presentations themselves, which will provide a springboard for reading assignments, seminar discussions, and research papers in the history of music and art. We will also examine the historical development of cultural institutions in Pittsburgh. The History Department will pay for students’ admission to all museums and studios. However, students will be charged a supplemental fee of a minimum of $225 to help subsidize the considerable expense of purchasing tickets for concerts and performances by the Pittsburgh Symphony, Pittsburgh Opera, Chamber Music Society, and Renaissance and Baroque Society. Attendance at all art exhibits and musical events is required. Prerequisite: Availability to attend art exhibits on several Fridays and Saturdays, and to attend musical events on several Thursday, Friday and Saturday evenings.

97-396 Music and Society in 19th and 20th Century Europe and the U.S.
Intermittent: 9 units
This course will consider the interrelations between society and classical and popular music in the nineteenth and twentieth centuries in Europe and the United States. We will examine the importance of different musical forms in the life of society and how music contributed to the making of political consciousness, especially in the twentieth century. In addition to reading assignments, seminar discussions, and research papers in the history of music, students will be taken to the performances of the Pittsburgh Symphony, Pittsburgh Opera, and Chamber Music Society. A supplemental fee of a minimum of $225 will be charged to subsidize part of the considerable expense of purchasing tickets for concerts and performances. Prerequisite: Availability to attend musical events on several Thursday, Friday, and Saturday evenings.

97-398 Documenting the 1967 Arab-Israeli War
Intermittent: 9 units
This course considers how historians practice their craft in interpreting great events. The Arab-Israeli war of 1967 serves as the case study. Students will read (DEL a) recent scholarly accounts of the war and then check them against one another as well as a variety of primary source materials such as memoirs, documents, speeches, newspapers, maps, eye-witness reports and UN resolutions. Visual sources (photographs) will constantly be asking if the sources support the secondary accounts or if there are other interpretations that might lead to different conclusions. We will be examining the texts for tangents left unexplored and possibly worthy of further research. Students should expect a significant reading load, frequent assignments and a major final research paper on a 1967 War-inspired topic.

97-399 US-Arab Encounters
Intermittent: 9 units
What is the nature of the relationship between the United States and the Arab countries? How do Americans and Arabs regard one another? This is an innovative cross-cultural course that enables CMU students in Pittsburgh and at the CMU campus in Qatar to interact with one another and with students at other American and Arab universities in exploring the US-Arab relationship. The goal is to improve awareness and understanding. Students will delve into themes and questions within an interdisciplinary framework that includes history, international relations, conflict resolution and media studies. Topics range from the role of religion in society to an investigation of the part media plays in shaping US and Arab perceptions. Topi

97-400 Advanced Seminar in Global Studies
Fall and Spring: 12 units
This research seminar is the capstone course for Global Studies majors. The course is designed to give you a chance to refine and carry out a research project of personal interest. The first few weeks of the course will be devoted to developing a research topic and locating sources. We will then work on how to interpret and synthesize sources into a coherent and compelling thesis or argument before you begin drafting your paper. Your research may be based on in-depth reading of a body of scholarly work, field notes from ethnographic observations, archival research, analysis of literary or visual media, or some combination of these sources. Incorporation of some non-English language sources is strongly encouraged where possible. Independent work, self-initiative, participation in discussion, and peer evaluations are required. There are several interim deadlines that will be strictly enforced in order to ensure successful completion of the course. Prerequisites: 79-275 and Theoretical and Topical Core must be complete or concurrently enrolled. Prerequisite: 79-275.

97-420 Advanced Studies in History
Fall: 12 units
This course will focus on a theme, concept, or category that has been central to the historical investigation of society and culture in a variety of places and times. Colloquium topics may include social groups and classes (peasants, workers), social institutions (family, state), socio-cultural identities (ethnicity, religion), political-cultural identities (nationalism), or socio-economic development (agriculture, industrialization). Examining its chosen theme from a variety of angles, the course will consider how historians of different regions have applied key theoretical approaches and definitions. Students will also engage in an independent research project on the course topic. This course is designed for advanced history majors. Prerequisite: 79-360.

97-449 Ethics, History, and Public Policy Project Course
Fall: 12 units
The Ethics, History, and Public Policy Project Course is required for the Ethics, History, and Public Policy major and is taken in the fall semester of the senior year. In this capstone course, Ethics, History, and Public Policy majors carry out a collaborative research project that examines a compelling current policy issue that can be illuminated with historical research and philosophical and policy analysis. The students develop an original research report based on both archival and contemporary policy analysis and they present their results to a client organization in the community.

97-491 Independent Study
All Semesters
An Independent Study is meant for students with a special interest in an area not covered by a formal history course. Readings and other work are negotiated between the student and an individual faculty member.

97-503 Senior Thesis I
Fall: 9 units
Seniors may write a thesis with permission of the Undergraduate Advisor and a designated faculty member who will supervise its completion.

97-504 Senior Thesis II
Spring: 9 units
Seniors may write a thesis with permission of the Undergraduate Advisor and a designated faculty member who will supervise its completion.

97-506 Global Studies Internship
Intermittent: 9 units
This course provides Global Studies majors with a chance to explore global connections in Pittsburgh. Majors, working in close consultation with the Global Studies director and advisor, may receive credit for a volunteer experience with a non-governmental organization (usually in Pittsburgh) whose mission has a global reach. This could include an organization that supports projects in other countries, works with immigrants in the Pittsburgh area, or participates in international policy making/governance. We strongly encourage students to seek out opportunities that require use of a second language. Students will be required to maintain journals, write a final critical reflection on how the internship connects to academic work, and share their experience with other Global Studies majors. Global Studies advisor and director will assist students with matching their interests to local organizations and identifying an on-site supervisor available to collaborate in the ongoing and final evaluation of the student work. Prerequisite: Students must be Global Studies majors and obtain prior permission for the proposed internship from the Global Studies advisor.
Human-Computer Interaction Courses

05-291 HCI for Computer Scientists
Spring: 12 units
This course introduces the skills and concepts of Human Computer Interaction (HCI) that enable computer scientists to design systems that effectively meet human needs. A concrete illustration of the practice of HCI, this course covers iterative design processes, interactive prototype construction, discount evaluation techniques, and the historical context of HCI. The course is intended for undergraduates and graduate students not majoring in HCI. Students considering a major in HCI should instead take 05-410, Introduction to HCI Methods. The prerequisite for HCI for non-majors is 15-211. Prerequisite: 15-211.

05-320 Social Web
12 units
With the growth of online environments like MySpace, Second Life, World of Warcraft, Wikipedia, blogs, online support groups, and open source development communities, the web is no longer just about information. This course, jointly taught by a computer scientist and a behavioral scientist, will examine a sampling of the social, technical and business challenges social web sites must solve to be successful, teach students how to use high-level tools to analyze, design or build online communities, and help them understand the social impact of spending at least part of their lives online. This class is open to advanced undergraduates and graduate students with either technical or non-technical backgrounds. Course work will include lectures and class discussion, homework, class presentations, and a group research or design project.

05-331 Building Virtual Worlds
Fall: 24 units
This is a project course, where interdisciplinary teams build desktop and immersive (helmet-based) interactive virtual worlds. The course will cover world building, environmental design, non-linear storytelling, and related topics. Students will use 3D Studio Max (CAD modeler), paint tools, such as Adobe Photoshop and DeepPaint, sound processing tools, and the Alice authoring system (www.alice.org/bvw.htm). Each year, we hold an exhibition in McConomy auditorium to show class projects to the Carnegie Mellon community. The goal of the course is to take students with varying talents, backgrounds, and perspectives and put them together to do what they couldn’t do alone. The course is targeted at undergraduates, but grad students may also enroll. To enroll, students must have ONE of the following skills: Modeling with 3D Studio Max Painting using shadow/shape/light in a realistic style: Programming, as evidenced by using the Alice system (www.alice.org); Ability to compose and record original music; Storyboarding Production tracking. The key is that there are no “idea people” in the course; everyone must share in the mechanical creation of the worlds. This is a hands-on course and it takes a lot of time, but most students find it very fulfilling and fun. Note that we don’t try to teach artists to program, or engineers to paint; we form teams where everyone does what they’re already skilled at to attack a joint project. Class time is roughly split between regular lectures, display/critique of group projects, and guest lectures.

05-391 Designing Human Centered Software
12 units
Why are things so hard to use these days? Why doesn’t this thing I just bought work? Why is this web site so hard to use? These are frustrations that we have all faced from systems not designed with people in mind. The question this course will focus on is: how can we design human-centered systems that people find useful and usable? This course is an introduction to designing, prototyping, and evaluating user interfaces. If you take only one course in Human-Computer Interaction, this is the course for you. This class is open to all undergrads and grad students, with either technical or non-technical backgrounds. We will cover theory as well as practical application of ideas from Human-Computer Interaction. Course work includes lectures, class discussion, homework, class presentations, and group project.

05-395 Applications of Cognitive Science
Spring: 9 units
The goal of this course is to examine cases where basic research on cognitive science, including cognitive neuroscience, has made its way into application, in order to understand how science gets applied more generally. The course focuses on applications that are sufficiently advanced as to have made an impact outside of the research field per se; for example, as a product, a change in practice, or a legal statute. Examples are virtual reality (in vision, hearing, touch), cognitive tutors, phonologically based reading programs, latent semantic analysis applications to writing assessment, and measures of consumers’ implicit attitudes. The course will use a case-study approach that considers a set of applications in detail, while building a general understanding of what it means to move research into the applied setting. The questions to be considered include: What makes a body of theoretically based research applicable? What is the pathway from laboratory to practice? What are the barriers - economic, legal, entrenched belief or practice? The format will emphasize analysis and discussion by students. They should bring to the course an interest in application; extensive prior experience in cognitive science is not necessary. The course will include tutorials on basic topics in cognitive science such as perception, memory, and spatial cognition. These should provide sufficient grounding to discuss the applications.

05-410 User-Centered Research and Evaluation
Fall: 12 units
This course provides overview and introduction to the field of human-computer interaction (HCI). It introduces students to tools, techniques, and sources of information about HCI and provides a systematic approach to design. The course increases awareness of good and bad design through observation of existing technology, and teaches the basic skills of task analysis, and analytic and empirical evaluation methods. This is a companion course to courses in visual design (51-422) and software implementation (05-430, 05-431). This course is NOT open to students outside the HCI major. Sophomores must get permission of the instructor.

05-411 Cognitive Crash Dummies
6 units
Crash dummies in the auto industry save lives by testing the physical safety of automobiles before they are brought to market. “Cognitive crash dummies” save time, money, and potentially even lives, by allowing computer-based system designers to test their design ideas before implementing them in products and processes. This mini-course will review the state of the art of perceptual, cognitive and motor modeling for assessing designs before building working systems. This course will include reading breaking research in predicting different aspects of human performance and building models in established modeling frameworks. No prior experience in human performance modeling is assumed; students from all disciplines are welcome.

05-413 Human Factors
Fall: 9 units
This course uses theory and research from human factors, cognitive science, and social science to understand and design the interactions of humans with the built world, tools, and technology. The course emphasizes current work in applied domains such as automotive design, house construction, medical, human factors, and design of informatics, devices. The course will emphasize not only individual human factors (e.g., visual response, anthropometry) but also the organizational arrangements that can amplify or correct human factors problems. Through reading, discussion, and projects, you will learn about human interacting, cognitive, and physical processes that affect how people interact with, and use, technology and tools. You will learn why we have so many automobile accidents, voting irregularities, and injuries from prescription medication. You will learn some tried and true solutions for human factors problems, and some of the many problems in human factors that remain. You will also have gained experience in research in this field.

05-417 Computer-mediated Communication
Spring: 6 units
This course examines fundamental aspects of interpersonal communication and considers how different types of computer-mediated communications (CMC) technologies affect communication processes. Among the topics we will consider are: conversational structure and CMC, tools to support nonverbal and paralinguistic aspects of communication such as gesture and eye gaze, and social and cultural dimensions of CMC. Students will be expected to post to weekly discussion lists, write short papers on a specific aspect of CMC, and to present a talk on their final project to the class. The course should be appropriate for graduate students in all areas and for advanced undergraduates.
05-430 Programming Usable Interfaces
Spring: 6 units
This course is for those with moderate programming skills who want to express their interactive ideas in working prototypes. The course will cover several prototyping tools and require a number of projects to be constructed in each. These will range from animated mock-ups through fully functional programs. The course will also cover usability testing of interactive prototypes. Prerequisites: proficiency in a programming language such as C, programming methodology and style, problem analysis, program structure, algorithm analysis, data abstraction, and dynamic data, normally met through an introductory course in programming in C, C++, Pascal or JAVA.
Prerequisites: 15-110 or 15-112 or 15-127.

05-431 Software Structures for User Interfaces
Fall: 6 units
This course is intended for those with advanced programming skills who want to do serious development of graphical user interfaces. This course includes: an introduction to task analysis and functional design of the user interface; basic principles of computer graphics used in UI implementation; event handling and event dispatching models; screen update algorithms and multi-view architectures; input syntax formalisms and their transformation into programs; interactive geometry; architectures for advanced features such as cut/copy/paste, macros and groupware. The course is intended for computer science majors. In some cases, the student and the Program Director will jointly determine the choice of 05-430 or 05-431, based upon the student’s previous programming experience.

05-432 Cognitive Modeling and Intelligent Tutoring Systems
Fall
Cognitive Modeling and Intelligent Tutoring Systems 05-432 / 05-832 This course is offered as a 9-credit version and a 12-credit version. The 9-credit version of the course does not involve programming, the 12-credit version involves rule-based programming, as detailed below. This course addresses the use of cognitive psychology and cognitive task analysis to create computer-based intelligent tutoring systems. Students will learn data-driven and theoretical methods for creating cognitive models of human problem solving. Such models have been used to create educational software that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. This type of software, which originated at CMU and is now widely used in US high schools and middle schools, is probably the premier application of cognitive science in education. In addition to discussion and readings on methods and models of problem solving, learning, and tutor design, the course will have a substantial “learning by doing” component. Students will be analyzing data, designing cognitive models and interfaces, and implementing an intelligent tutoring system. Students will use CTAT (the Cognitive Tutor Authoring Tools, see http://c Tat.pact.cs.cmu.edu) to construct tutors. Tutors built with CTAT for middle-school mathematics can be found on the MathTutor web site (http://mathtutor.web.cmu.edu). The hands-on portion of the course differs between the 9-credit version or the 12-credit version. In the 9-credit version of the course, students will use the CTAT tools for constructing tutors. In this version of the course, no programming is required and no programming background is needed. In the 12-credit version of the course, students will learn to create rule-based cognitive models for more sophisticated tutors, a form of Artificial Intelligence programming. They will learn to program
Prerequisites: 15-211 or 85-213 or 84-411.

05-433 User Interface Lab
Fall: 9 units
This is a project-oriented course, which will deal with all four aspects of project development: the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time. Upon completion of this course each student will be able to: generate systems specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided development tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time.

05-540 Rapid Prototyping of Computer Systems
Spring: 12 units
This is a project-oriented course, which will deal with all four aspects of project development: the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time. Upon completion of this course each student will be able to: generate systems specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided development tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time.

05-571 Undergraduate Project in HCI
Spring: 12 units
Experiential learning is a key component of the MHCI program. Through a substantial team project, students apply classroom knowledge in analysis and evaluation, implementation and design, and develop skills working in multidisciplinary teams. Student teams work with Carnegie Mellon University-based clients or external clients to iteratively design, build and test a software application which people directly use.
Prerequisites: 05-410 or 05-610.
Corequisites: 05-631, 05-431.

05-589 Independent Study in HCI-UG
All Semesters
In collaboration with and with the permission of the professor, undergraduate students may engage in independent project work on any number of research projects sponsored by faculty. Students must complete an Independent Study Proposal, negotiate the number of units to be earned, complete a contract, and present a tangible deliverable. The Undergraduate Program Advisor’s signature is required for HCI undergraduate-level Independent Study courses.

05-600 HCI Pro Seminar
Fall: 6 units
Students will attend the one-hour weekly HCI Seminar Series of talks given by national leaders in the field of Human-Computer Interaction. Graduate students will then meet to discuss these topics in a small-group symposium.

05-831 Building Virtual Worlds
Fall: 24 units
This is a project course, where interdisciplinary teams build desktop and immersive (helmet-based) interactive virtual worlds. The course will cover world-building, environmental storytelling, relevant topics. Students will use 3D Studio Max (CAD modeler), paint tools, such as Adobe Photoshop and DeepPaint, sound processing tools, and the Alice authoring system (www.alice.org/bwr.htm). Each week, we hold an exhibition in McConomy auditorium to show class projects to the Carnegie Mellon community. The goal of the course is to take students with varying talents, backgrounds, and perspectives and put them together to do what they couldn’t do alone. The course is targeted at undergraduates, but grad students may also enroll. Students must enroll in the following skills: Modeling with 3D Studio Max Painting using shadow/shape/light in a realistic style Programming, as evidenced by using the Alice system (www.alice.org) Ability to compose and record original music Storyboarding Production tracking Other relevant skills. The key thing is that there are no “idea people” in the course; everyone must share in the mechanical creation of the worlds. This is a hands-on course and it takes a lot of time, but most students find it very fulfilling and fun. Note that we don’t try to teach artists to program, or engineers to paint; we form teams where everyone does what they’re already skilled at to attack a joint project. We are scheduled for 2 weekly meetings, 2.5 hours each. These slots are roughly split between regular lectures, display/critique of group projects, and guest lectures.

Institute for Software Research Courses

08-200 Ethics and Policy Issues in Computing
Spring: 9 units
In this course, students will study the social impacts of computing technology and systems. The course will provide a broad introduction to ethics and to the history of computing and the Internet. It will focus on a number of areas in which computers and information technology are having an impact on society including privacy, freedom of speech, intellectual property, work, distribution of wealth, and the environment. Current issues that will be discussed include electronic voting, spyware, spam, and intellectual property issues associated with digital content distribution. This course is intended for freshmen and sophomore students from across the university. There are no pre-requisites.
08-202 Computational Approaches to Social Complexity
Spring: 9 units
Everything is connected! From small groups to economic markets to global societies - interactions among people, organizations, technology, and policies lead to complex systems. These connected systems cannot be described with simple equations but rather with networks, non-linearities and tipping points. This course covers a set of computational approaches to analyzing and understanding the dynamics of the social world. Techniques include data capture, social network analysis, advanced information visualization, and agent based simulation. Students will engage in hands-on projects learning these techniques to explain and predict social changes arising from the complexity of everyday life.

08-463 Service Innovation
Spring: 6 units
This course introduces students to the concept of services and their increasing role in the global economy and global employment, and explores services as a part of a goods-services continuum ranging from products or goods to service encapsulation of products to pure services. Service innovation is defined, and contrasts drawn between service and product innovation. Service innovation mechanisms and barriers to innovation are explored, as are organizational outcomes and measurement of service innovation. Course discussion identifies selected issues in service innovation, such as the innovation value chain, co-creation of service innovations, service innovation for sustainability, innovation in public service, changes in employment, globalization of service innovation, service design, or the ethics of service innovation; and assesses the impact of these on future service innovation agendas.

08-533 Privacy, Policy, Law and Technology
Fall and Spring: 9 units
As new technologies are developed, they increasingly raise privacy concerns—the Web, wireless location-based services, and RFID are a few examples. In addition, the recent focus on fighting terrorism has brought with it new concerns about governmental intrusions on personal privacy. This course provides an in-depth look into privacy, privacy laws, and privacy-related technologies. Students will study privacy from philosophical, historical, legal, policy, and technical perspectives and learn how to engineer systems for privacy. This course is appropriate for graduate students, juniors, and seniors who have strong technical backgrounds. 8-733 is for PhD students. 8-533 and 19-608 are for undergraduate students. Masters students may register for any of the course numbers. This course will include a lot of reading, writing, and class discussion. Students will be expected to do some writing and some technical work. A large emphasis will be placed on research and communication skills, which will be taught throughout the course.

08-733 Privacy, Policy, Law and Technology
Fall: 12 units
As new technologies are developed, they increasingly raise privacy concerns—the Web, wireless location-based services, and RFID are a few examples. In addition, the recent focus on fighting terrorism has brought with it new concerns about governmental intrusions on personal privacy. This course provides an in-depth look into privacy, privacy laws, and privacy-related technologies. Students will study privacy from philosophical, historical, legal, policy, and technical perspectives and learn how to engineer systems for privacy. This course is appropriate for graduate students, juniors, and seniors who have strong technical backgrounds. 8-733 is for PhD students. 8-533 and 19-608 are for undergraduate students. Masters students may register for any of the course numbers. This course will include a lot of reading, writing, and class discussion. Students will be expected to do some writing and some technical work. A large emphasis will be placed on research and communication skills, which will be taught throughout the course.

08-801 Dynamic Network Analysis
Fall and Spring: 12 units
Who knows who? Who knows what? Who is influential? How do ideas, products & diseases propagate through groups? How do new sciences emerge? Do interactions show a pattern of life? Questions such as these & millions of others require a network perspective and an understanding of how ties among people, ideas, things, & locations connect, constrain & enable activity. The study of networks is integral to many fields: statistics, sociology, organizations, communication, computer science & forensic science. Many disciplines provide theories & models of network formation, evolution & impact; relevant data; technologies; algorithms; & metrics. Whether referred to as link analysis, social network analysis, or network science, the discussion hinges on the graph-theoretic based study of dynamic, ubiquitous, & interlocked networks with statistical techniques for assessing dynamics, information loss, & error. This course takes an interdisciplinary approach. The relation of social networks to knowledge, communication, activity & other networks is considered. Applications from business, science, art, forensics, & numerous other areas are explored. In this course, the fundamentals of network science, the methods, the theories, the research, the applications & the caveats are discussed. Questions addressed include: How do we conceptualize, measure, compare & evaluate various types of networks? How do we evaluate the impact of policies & technology on dynamic networks? What nodes, relations, groups, or motifs stick out or are influential in a network? How do networks emerge, evolve, & change? This graduate seminar is taught every other year. Prior courses in linear algebra, graph theory, or social networks are not required. Students are encouraged to bring & use their own data, or to use one of the datasets publicly available for assignments.

Language Technologies Institute Courses

11-344 Machine Learning in Practice
Fall: 12 units
Machine Learning is concerned with computer programs that enable the behavior of a computer to be learned from examples or experience rather than dictated through rules written by hand. It has practical value in many application areas of computer science such as on-line communities and digital libraries. This class is meant to teach the practical side of machine learning for applications, such as mining newsgroup data or building adaptive user interfaces. The emphasis will be on learning the process of applying machine learning effectively to a variety of problems rather than emphasizing an understanding of the theory behind what makes machine learning work. This course does not assume any prior exposure to machine learning theory or practice. In the first 2/3 of the course, we will cover a wide range of learning algorithms that can be applied to a variety of problems. In particular, we will cover topics such as decision trees, rule-based classification, support vector machines, Bayesian networks, and clustering. In the final third of the class, we will go into more depth on one application area, namely the application of machine learning to problems involving text processing, such as information retrieval or text categorization.

11-411 Natural Language Processing
Spring: 12 units
This course introduces students to the highly interdisciplinary area of Artificial Intelligence known alternately as Natural Language Processing (NLP) and Computational Linguistics. The course aims to cover the techniques used today in software that does useful things with text in human languages like English and Chinese. Applications of NLP include automatic translation between languages, extraction and summarization of information in documents, question answering and dialog systems, and conversational agents. This course will focus on core representations and algorithms, with some time spent on real-world applications. Because modern NLP relies so heavily on Machine Learning, we’ll cover the basics of discrete classification and probabilistic modeling as we go. Good computational linguists also know about Linguistics, so topics in linguistics (phonology, morphology, and syntax) will be covered when fitting. From a software engineering perspective, there will be an emphasis on rapid prototyping, a useful skill in many other areas of Computer Science. In particular, we will introduce some high-level languages (e.g., regular expressions and Dyna) and some scripting languages (e.g., Python and Perl) that can greatly simplify prototype implementation.
Prerequisite: 15-122.
11-441 Search Engines and Web Mining
12 units
This course provides a comprehensive introduction to the theory and implementation of algorithms for organizing and searching large text collections. The first half of the course studies text search engines for enterprise and Web environments; the open-source Indri search engine is used as a working example. The second half studies text mining techniques such as clustering, categorization, and information extraction. Programming assignments give hands-on experience with document ranking algorithms, categorizing documents into browsing hierarchies, and related topics.

11-617 Language Technologies for Computer Assisted Language Learning
Spring: 12 units
This course studies the design and implementation of CALL systems that use Language Technologies such as Speech Synthesis and Recognition, Machine Translation, and Information Retrieval. After a short history of CALL/ LT, students will learn where language technologies (LT) can be used to aid in language learning. From there, the course will explore the specifics of designing software that must interface with a language technology. For each LT, we will explore: • what information does the LT require • what type of output does the LT send to the CALL interface • what are the limits of the LT that the CALL designer must deal with • what are the real time constraints • what type of training does the LT require The goal of the course is to familiarize the student with • existing systems that use LT • assessment of CALL/ LT software • the limitations imposed by the LT • designing CALL/ LT software Grading criteria: • several short quizzes • term project: production of a small CALL/ LT system, verbal presentation and written documentation of design of the software.

11-711 Algorithms for NLP
All Semesters: 12 units
Algorithms for NLP is an introductory graduate-level course on the computational properties of natural languages and the fundamental algorithms for processing natural languages. The course will provide an in-depth presentation of the major algorithms used in NLP, including Lexical, Morphological, Syntactic and Semantic analysis, with the primary focus on parsing algorithms and their analysis.

11-716 Graduate Seminar on Dialog Processing
All Semesters: 6 units
Dialog systems and processes are becoming an increasingly vital area of interest both in research and in practical applications. The purpose of this course will be to examine, in a structured way, the literature in this area as well as learn about ongoing work. The course will cover traditional approaches to the problem, as exemplified by the work of Grosz and Sidner, as well as more recent work in dialog, discourse and evaluation, including statistical approaches to problems in the field. We will select several papers on a particular topic to read each week. While everyone will do all readings, a presenter will be assigned to overview the paper and lead the discussion. On occasion, a researcher may be invited to present their own work in detail and discuss it with the group. A student or researcher taking part in the seminar will come away with a solid knowledge of classic work on dialog, as well as familiarity with ongoing trends.

11-721 Grammars and Lexicons
All Semesters: 12 units
Grammars and Lexicons is an introductory graduate course on linguistic data analysis and theory, focusing on methodologies that are suitable for computational implementations. The course covers major syntactic and morphological phenomena in a variety of languages. The emphasis will be on examining both the diversity of linguistic structures and the constraints on variation across languages. Students will be expected to develop and defend analyses of data, capturing linguistic generalizations and making correct predictions within and across languages. The goal is for students to become familiar with the range of phenomena that occur in human languages so that they can generalize the insights into the design of computational systems. The theoretical framework for syntactic and lexical analysis will be Lexical Functional Grammar. Grades will be based on problem sets and take-home exams.

11-722 Grammar Formalisms
Intermittent: 12 units
The goal of this course is to familiarize students with grammar formalisms that are commonly used for research in computational linguistics, language technologies, and linguistics. We hope to have students from a variety of disciplines (linguistics, computer science, psychology, modern languages, philosophy) in order to cover a broad perspective in class discussions. Comparison of formalisms will lead to a deeper understanding of human language and natural language processing algorithms. The formalisms will include: Head Driven Phrase Structure Grammar, Lexical Functional Grammar, Tree Adjoining Grammar and Categorial Grammar. If time permits, we will cover Penn Treebank, dependency grammar, and Construction Grammar. We will cover the treatment of basic syntactic and semantic phenomena in each formalism, and will also discuss algorithms for parsing and generating sentences for each formalism. If time permits, we may discuss formal language theory and generative capacity. The course is taught jointly by the following faculty of the Language Technologies Institute: Alan Black, Alon Lavie, Lori Levin (main coordinator).

11-731 Machine Translation
Spring: 12 units
Instructors: Teruko Mitamura (leader), Bob Frederking, Eric Nyberg, Alon Lavie
Prerequisites: 11-721 "Grammars and Lexicons" or equivalent background is recommended. 11-711 "Algorithms for NLP" or equivalent background is recommended. Course Description Machine Translation is an introductory graduate-level course surveying history, techniques, and research topics in the field. The main objectives of the course are: Obtain a basic understanding of MT systems and MT-related issues. Learn about theory and approaches in Machine Translation. Learn about basic techniques for MT development, in preparation for the MT Lab course and real-world MT system project development. Obtain in-depth knowledge of one current topic in MT, or Perform an analysis of a given MT problem, matching it with the most suitable techniques (includes research, report and presentation).

11-741 Information Retrieval
Spring: 12 units
This course studies the theory, design, and implementation of text-based information systems. The Information Retrieval core components of the course include statistical characteristics of text, representation of information needs and documents, several important retrieval models (Boolean, vector space, probabilistic, inference net, language modeling), clustering algorithms, automatic text categorization, and experimental evaluation. The software architecture components include design and implementation of high-capacity text retrieval and text filtering systems. A variety of current research topics are also covered, including cross-lingual retrieval, document summarization, machine learning, topic detection and tracking, and multi-media retrieval. Prerequisites: Programming and data-structures at the level of 15-212 or higher. Algorithms comparable to the undergraduate CS algorithms course (15-451) or higher. Basic linear algebra (21-241 or 21-341). Basic statistics (36-202) or higher.

11-751 Speech Recognition and Understanding
All Semesters: 12 units
The technology to allow humans to communicate by speech with machines or by which machines can understand when humans communicate with each other is rapidly maturing. This course provides an introduction to the theoretical tools as well as the experimental practice that has made the field what it is today. We will cover theoretical foundations, essential algorithms, major approaches, experimental strategies and current state-of-the-art systems and will introduce the participants to ongoing work in representation, algorithms and interface design. This course is suitable for graduate students with some background in computer science and electrical engineering, as well as for advanced undergraduates. Prerequisites: Sound mathematical background, knowledge of basic statistics, good computing skills. No prior experience with speech recognition is necessary. This course is primarily for graduate students in LTI, CS, Robotics, ECE, Psychology, or Computational Linguistics. Others by prior permission of instructor.
11-752 Speech II: Phonetics, Prosody, Perception and Synthesis  
Spring: 12 units  
The goal of the course is to give the student basic knowledge from several fields that is necessary in order to pursue research in automatic speech processing. The course will begin with a study of the acoustic content of the speech signal. The students will use the spectrographic display to examine the signal and discover its variable properties. Phones in increasingly larger contexts will be studied with the goal of understanding coarticulation. Phonological rules will be studied as a contextual aid in understanding the spectrographic display. The spectrogram will then serve as a first introduction to the basic elements of prosody. Other displays will then be used to study the three parts of prosody: amplitude, duration, and pitch. Building on these three elements, the student will then examine how the three interact in careful and spontaneous speech. Next, the students will explore perception. Topics covered will be: physical aspects of perception, psychological aspects of perception, testing perception processes, practical applications of knowledge about perception. The second part of this course will cover all aspects of speech synthesis. Students need only have a basic knowledge of speech and language processing. Some degree of programming and statistical modelling will be beneficial, but not required. Taught every other year.

11-761 Language and Statistics  
Spring: 12 units  
This course introduces some of the central themes and techniques that have emerged in statistical methods for language technologies and natural language processing. While many early NLP systems relied heavily on hand-crafted rules, during the past ten years a great deal of progress has been made using probabilistic methods that automatically and implicitly learn about language by extracting statistics from large quantities of text, thus reducing the knowledge acquisition bottleneck. As the computational power of computers increases, and as more natural language data becomes available on-line, statistical methods will become increasingly attractive and powerful in the future. Topics include the source-channel paradigm from information theory, predictive language models, hidden Markov models, the EM algorithm in its many guises, maximum entropy methods, and classification and regression techniques. Selected case studies involving technologies such as word and document clustering, sense disambiguation, parsing, text classification, and machine translation are presented. The material draws upon machine learning, statistics, and information theory, but only an elementary knowledge of probability is a prerequisite for the course.

11-762 Language and Statistics II  
Fall: 12 units  
This course will cover modern empirical methods in natural language processing. It is designed for language technologies students who want to understand statistical methodology in the language domain, and for machine learning students who want to know about current problems and solutions in text processing. Students will, upon completion, understand how statistical modeling and learning can be applied to text, be able to develop and apply new statistical models for problems in their own research, and be able to critically read papers from the major related conferences (EMNLP and ACL). A recurring theme will be the tradeoffs between computational cost, mathematical elegance, and applicability to real problems. The course will be organized around methods, with concrete tasks introduced throughout. The course is designed for SCS graduate students. Prerequisite: Language and Statistics (11-761) or permission of the instructor. Recommended: Algorithms for Natural Language Processing (11-711), Machine Learning (15-681, 15-781, or 11-746). Prerequisite: 11-761.

11-792 Intelligent Information Systems Project  
Spring: 12 units  
The Software Engineering for IS sequence combines classroom material and assignments in the fundamentals of software engineering (11-791) with a self-paced, faculty-supervised directed project (11-792). The two courses cover all elements of project design, implementation, evaluation, and documentation. Students may elect to take only 11-791; however, if both parts are taken, they should be taken in proper sequence. Prerequisite: 11-791. The course is required for VGIS students. Prerequisites: 11-791 or 15-393.

MCS Interdisciplinary Courses

38-210 BIOSSS: Biotechnology Impacting Our Selves, Societies and Spheres  
Intermittent: 6 units  
The biotechnology era has begun and its impact is being felt at multiple levels that range from individual effects to global concerns. Vocabularies are expanding to include words such as stem cells, genomics, SARS and anthrax while hearts and minds are grappling with related issues such as human cloning, DNA profiling, epidemic control and bioterrorism. Emerging infectious diseases have no respect for national boundaries and challenge our knowledge, resources and personal well-being. Understanding and responding to such personal, societal and global challenges requires a level of scientific literacy currently deficient in much of the general citizenry. In addition, scientists of the future must be able to apply their disciplinary knowledge within the context of relevant ethical, legal and societal influences. "B.I.O.S.3: Biotechnology Impacting Our Selves, Societies and Sphere is a course on biotechnology literacy and decision making in a global context. The guiding framework of the course curriculum design is centered on an application of the principles of the central dogma of biotechnology. The approach can be described as the "transcription" of core knowledge into context followed by the "translation" of that knowledge into global perspective and personal action. The course will involve the development and implementation of core topic modules. The first module piloted will focus on HIV/AIDS.

38-709 Applied Cell and Molecular Biology  
Fall: 12 units  
This course will examine applications of modern cell and molecular biology, with emphasis on commercial products and processes. The course will include a basic background in the major topics that would be covered in courses on prokaryotic and eukaryotic molecular biology and molecular cell biology. The course is intended for non-specialists who seek an understanding and appreciation of fundamental concepts without the analysis of experimental detail that would support the development of concepts in a course for the specialist. The course will draw on the patent literature as a source of commercial applications of biological discoveries. Examples of the topics that might be included are: diagnostic and therapeutic monoclonal antibodies (e.g., Herceptin), therapeutic proteins (e.g., colony stimulating factors, erythropoietin, hormones), antibiotics, subunit molecular vaccines, amino acid fermentations, enzyme based processes for chemical synthesis, gene therapy, stem cells and regenerative medicine, herbicide tolerant plants, microbial diagnostics (e.g., multilocus sequence typing), transgenic animals, DNA fingerprinting.

38-710 Principles of Biotechnology  
Spring: 12 units  
This course is intended to provide an introduction to a set of core areas currently highlighted in the biotechnology industries. The objective is to provide the appropriate background for management level personnel to optimize their decision-making based on knowledgeable background in today’s technologies. The focus will be on weekly modules of similar disciplines knowledge within the context of relevant ethical, legal and societal influences. "B.I.O.S.3: Biotechnology Impacting Our Selves, Societies and Spheres is a course on biotechnology literacy and decision making in a global context. The guiding framework of the course curriculum design is centered on an application of the principles of the central dogma of biotechnology. The approach can be described as the "transcription" of core knowledge into context followed by the "translation" of that knowledge into global perspective and personal action. The course will involve the development and implementation of core topic modules. The first module piloted will focus on HIV/AIDS.
Machine Learning Courses

10-601 Machine Learning
Fall and Spring: 12 units
Machine learning studies the question "how can we build computer programs that automatically improve their performance through experience?" This includes learning to perform many types of tasks based on many types of experience. For example, it includes robots learning to better navigate based on experience gained by roaming their environments, medical decision aids that learn to predict which therapies work best for which diseases based on data mining of historical health records, and speech recognition systems that learn to better understand your speech based on experience listening to you. This course is designed to give students an overview of the methods, theory, and algorithms of machine learning. The topics will include Decision Trees, Naïve Bayes, Logistic regression, Kernel regression, Support Vector Machines, EM algorithm, Clustering, Hidden Markov Models, Bayesian Networks, Bias-variance tradeoff, overfitting, PAC learning, and some advanced topics, if time permits. Students entering the class with a pre-existing working knowledge of probability, statistics and algorithms will be at an advantage, but the class has been designed so that anyone with a strong numerate background can catch up and fully participate. By the end of the class, students will have a working knowledge of the state of the art in Machine Learning, experience applying these algorithms to real-world data sets, and an ability to read and understand papers in the current research literature. For graduate students, the pre-reqs are to have a good basic understanding of computational complexity and data structures, and to be proficient at writing programs at least several hundred lines long in a general-purpose programming language such as JAVA, C++, or C. If you are interested in this topic, are a PhD student, and would like a more formal treatment of the material, you might consider 10-701.
Prerequisites: (15-122) and (21-127) and (36-217 or 36-225 or 21-325 or 15-359).

10-605 Machine Learning with Large Datasets
Spring: 12 units
Large datasets are difficult to work with for several reasons. They are difficult to visualize, and it is difficult to understand what sort of errors and biases are present in them. They are computationally expensive to process, and often the cost of learning is hard to predict - for instance, and algorithm that runs quickly in a dataset that fits in memory may be exorbitantly expensive when the dataset is too large for memory. Large datasets may also display qualitatively different behavior in terms of which learning methods produce the most accurate predictions. This course is intended to provide a student practical knowledge of, and experience with, the issues involving large datasets. Among the issues considered are: scalable learning techniques, such as streaming machine learning techniques; parallel infrastructures such as map-reduce; practical techniques for reducing the memory requirements for learning methods, such as feature hashing and Bloom filters; and techniques for analysis of programs in terms of memory, disk usage, and (for parallel methods) communication complexity. The class will include programming assignments, and a one-month short project chosen by the student. The project will be designed to compare the scalability of variant learning algorithms on datasets. An introductory course in machine learning, like 10-601 or 10-701, is a prerequisite or a co-requisite. If you plan to take this course and 10-601 concurrently please tell the instructor. The course will include several substantial programming assignments, so an additional prerequisite is 15-211, or 15-214, or comparable familiarity with Java and good programming skills. Undergraduates need permission of the instructor to enroll.
Prerequisites: 15-210 or 15-214
Corequisites: 10-701, 10-601.

10-701 Machine Learning
Fall and Spring: 12 units
Machine learning studies the question "how can we build computer programs that automatically improve their performance through experience?" This includes learning to perform many types of tasks based on many types of experience. For example, it includes robots learning to better navigate based on experience gained by roaming their environments, medical decision aids that learn to predict which therapies work best for which diseases based on data mining of historical health records, and speech recognition systems that learn to better understand your speech based on experience listening to you. This course is designed to give PhD students a thorough grounding in the methods, theory, mathematics and algorithms needed to do research and applications in machine learning. The topics of the course draw from from machine learning, from classical statistics, from data mining, from Bayesian statistics and from information theory. Students entering the class with a pre-existing working knowledge of probability, statistics and algorithms will be at an advantage, but the class has been designed so that anyone with a strong numerate background can catch up and fully participate. If you are interested in this topic, but are not a PhD student, or are a PhD student not specializing in machine learning, you might consider the master's level course on Machine Learning, 10-601.

Materials Science Engineering Courses

27-052 Introduction to NanoScience and Technology
Summer: 9 units
This course is offered within Carnegie Mellon's Advanced Placement Early Admissions (APEA) program. The course is primarily intended to provide an introduction to nanoscience and technology to a wide audience of students at the advanced high school to incoming freshmen level. The course goals are twofold: (1) to provide students with a holistic view of the objectives, opportunities and challenges of the emerging field of nanotechnology and 2) to sensitize students at an early stage of their career to the relevance of the connections among the traditional disciplines as a vital element to the progress in interdisciplinary areas such as nanotechnology. The course will cover: Introduction and fundamental science; Preparation of nanostructures; Characterization of nanostructures; Application examples, Social and ethical aspects of nanotechnology. Admission according to APEA guidelines.

27-100 Engineering the Materials of the Future
Fall and Spring: 12 units
Materials form the foundation for all engineering applications. Advances in materials and their processing are driving all technologies, including the broad areas of nano-, bio-, energy, and electronic (information) technology. Performance requirements for future applications require that engineers continue to design both new structures and new processing methods in order to engineer materials having improved properties. Applications such as optical communication, tissue and bone replacement, fuel cells, and information storage, to name a few, exemplify areas where new materials are required to realize many of the envisioned future technologies. This course provides an introduction to how science and engineering can be exploited to design materials for many applications. The principles behind the design and exploitation of metals, ceramics, polymers, and composites are presented using examples from everyday life, as well as from existing, new, and future technologies. A series of laboratory experiments are used as a hands-on approach to illustrating modern practices used in the processing and characterization of materials and for understanding and improving materials’ properties.
Corequisites: 33-106, 21-120.

27-201 Structure of Materials
Fall: 9 units
This course covers the fundamentals of crystallography and diffraction. Topics covered include: the periodic table of the elements, bonding in different classes of materials, Bravais lattices, unit cells, directions and planes, crystal geometry computations, direct and reciprocal space, symmetry operations, point and space groups, nature of x-rays, scattering in periodic solids, Bragg’s law, the structure factor, and the interpretation of experimental diffraction patterns. 24 crystal structure types of importance to various branches of materials science and engineering will be introduced. Amorphous materials, composites and polymers are also introduced. This course includes both lectures and laboratory exercises.
Prerequisite: 21-122
Corequisite: 27-100.
27-202 Defects in Materials
Fall: 9 units
Defects have a fundamental influence on the properties of materials, including deformation, electrical, magnetic, optical, and chemical properties, as well as the rates of diffusion in solids. As such, by controlling the population of intrinsic and extrinsic defects, one can tailor the properties of materials towards specific engineering applications. The objective of this course, which includes classroom and laboratory sessions, is to define approaches to quantifying the populations and properties of defects in crystals. The course will be divided into three sections: point defects, dislocations, and planar defects. The formation of point defects and their influence on diffusion, electrical, and magnetic properties will be considered. The properties and characteristics of dislocations and dislocation reactions will be presented, with a focus on the role of dislocations in deformation. The crystallography and energetics of planar defects and interfaces will also be described, with a focus on microstructural evolution at high temperatures. Time permitting, volume defects or other special topics are also discussed.
Prerequisite: 21-122
Corequisite: 27-100.

27-205 Introduction to Materials Characterization
Spring: 3 units
The course introduces the modern methods of materials characterization, including characterization of microstructure and microchemistry of materials. A classroom component of the course will introduce the wide array of methods and applications of characterization techniques. Basic theory will be introduced where needed. Students will then be instructed in the use of several instruments such as AFM, SEM, and EDS, using a hands-on approach. All instruments are part of the existing lab facilities within MSE and CIT. The methods learned in this course will serve the student during several other higher level courses, such as the Senior level MSE Capstone Course (27-401).

27-211 Structure of Materials (Minor Option)
6 units
This course is identical to 27-201, but without the 3-unit lab component.

27-212 Defects in Materials (Minor Option)
6 units
THIS IS FOR THE MSE MINOR ONLY: Defects have a fundamental influence on the properties of materials, including deformation, electrical, magnetic, optical, and chemical properties, as well as the rates of diffusion in solids. As such, by controlling the population of intrinsic and extrinsic defects, one can tailor the properties of materials towards specific engineering applications. The objective of this course, which includes classroom and laboratory sessions, is to define approaches to quantifying the populations and properties of defects in crystals. The course will be divided into three sections: point defects, dislocations, and planar defects. The formation of point defects and their influence on diffusion, electrical, and magnetic properties will be considered. The properties and characteristics of dislocations and dislocation reactions will be presented, with a focus on the role of dislocations in deformation. The crystallography and energetics of planar defects and interfaces will also be described, with a focus on microstructural evolution at high temperatures. Time permitting, volume defects or other special topics are also discussed.

27-215 Thermodynamics of Materials
Fall: 12 units
The first half of the course will focus on the laws of thermodynamics and the inter-relationships between heat, work and energy. The concept of an equilibrium state of a system will be introduced and conditions which must be satisfied for a system to be at equilibrium will be established and discussed and the concepts of activity and chemical potential introduced. The second half of the course will focus on chemical reactions, liquid and solid solutions, and relationships between the thermodynamics of solutions and binary phase diagrams.
Corequisites: 27-100, 21-250.

27-216 Transport in Materials
Spring: 9 units
This course is designed to allow the student to become familiar with the fundamental principles of heat flow, fluid flow, mass transport and reaction kinetics. In addition, the student will develop the skills and methodologies necessary to apply these principles to problems related to materials manufacture and processing. Topics will include thermal conductivity, convection, heat transfer equations, an introduction to fluid phenomena viscosity, etc., Newtons and Stokes Laws, mass momentum balances in fluids, boundary layer theory, diffusion and absolute reaction rate theory. Where appropriate, exam problems will be taken from problems related to the design of components and the processing of materials.
Prerequisites: 15-110 and 27-215.

27-217 Phase Relations and Diagrams
Spring: 12 units
Prerequisites: 27-201 and 27-202 and 27-215
Corequisite: 09-105.

27-299 Professional Development I
Fall: 1 unit
This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics I, II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers, ceramics and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-301 Microstructure and Properties I
Fall: 9 units
The objective of this course and its companion 27-302 is to convey some of the essential concepts in materials science and engineering that relate material properties (strength, magnetism, thermal expansion) to microstructure (crystal structure, dislocations structure, grain structure, precipitate structure, composite structure) in single phase materials. The relationships will be illustrated with examples of both idealized and technological materials. The course will draw upon many aspects of materials science such as defects, phase transformations etc. The course includes both lectures and laboratory exercises.
Prerequisites: 27-216 and 27-217.

27-302 Microstructure and Properties II
Spring: 9 units
This course applies the principles and ideas developed in 27-301 to multiphase materials. The structure-property relationships will be illustrated with examples of both idealized and technological materials. The course will draw upon many aspects of materials science such as defects, phase transformations etc. The course includes both lectures and laboratory exercises.
Corequisite: 27-301.

27-311 Polymeric Biomaterials
Spring: 9 units
This course will provide students with an introduction to polymers used in medical applications. Following a brief discussion of the physical properties of polymers and tissues, we will survey important classes of polymeric biomaterials, discussing material preparation, processing, properties and applications. Topics will include silicone elastomers, degradable hydrogels, ultra-high molecular weight polyethylene, polyurethanes, polyesters, and biopolymers such as silks and collagen. In addition, students will participate in a semester-long entrepreneurship project where they propose a new medical technology based on polymeric biomaterials. This semester we will discuss this primarily in the context of materials for wound healing applications. Student teams will perform market research on wound healing products, propose a novel bioactive dressing for wound healing applications, and identify methods for the testing and production of their product.

27-312 Metallic and Ceramic Biomaterials
Fall: 9 units
The course addresses basic and applied concepts of metals and ceramics as biomaterials. The students will be exposed to the principles, properties and applications of amorphous and crystalline inorganic and metallic systems for biological applications. Specific emphasis will be placed on processing biochemical activity, biodegradation mechanisms, and various properties relevant for specific applications. Topics will include thermal conductivity, convection, heat transfer equations, an introduction to fluid phenomena viscosity, etc., Newtons and Stokes Laws, mass momentum balances in fluids, boundary layer theory, diffusion and absolute reaction rate theory. Where appropriate, exam problems will be taken from problems related to the design of components and the processing of materials.
Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful.
27-322 Processing of Metals
Fall: 9 units
This course addresses the principles of processing of metals and the relationship between processing and performance. Topics include chemical thermodynamics, reaction kinetics, surfaces, fundamentals of heat treatment, process engineering, powder handling, powder compaction, densification and sintering. These aspects of processing science will be applied to the processing of metals including electrometallurgy, hydrometallurgy, pyrometallurgy, extraction, refining, and specific examples of alloy systems such as the production of steel, aluminum or titanium. The principles and practice of materials processing will be applied to process optimization. The relationship between processing methods and the environment will be discussed. The impact of the processing history of materials will be discussed in relation to material performance and lifetime. The concept of the lifecycle of materials will be discussed.

27-323 Powder Processing of Materials
Fall: 9 units
This course addresses the methods used in, and the principles that underlie, powder processing of metals and ceramics. Aspects of powder processing will be discussed in relation to the use of materials in engineering applications. The relationship between processing methods and materials performance in select applications will be discussed using specific materials examples including metals and ceramics. The course is broken down into three main parts: (1) understanding, selecting, and controlling powder characteristics; (2) powder handling, compaction, and forming techniques; and (3) drying, burnout, densification, sintering, and grain growth in powder compacts. Topics include chemical thermodynamics, reaction kinetics, surfaces, colloids, dispersions, process engineering, powder handling, powder compaction, shape forming, densification, and sintering. Prerequisites: 27-100 and 27-202 and 27-215 and 27-216.

27-324 Introduction to Polymer Science and Engineering
Fall: 9 units
This course introduces the fundamental properties of polymer materials and the principles underlying the design as well as the engineering and manufacturing of polymer materials. The basic characteristics of macromolecules will be discussed followed by an introduction to relevant forming technologies and their significance to material performance. Technologically relevant engineering properties of polymer materials will be introduced with focus on mechanical, electrical, and optical properties. Selected case studies and design projects will introduce students to the various stages of technical product development, i.e. problem analysis, material selection and processing plan.

27-325 Polymer Physics and Morphology
Fall: 9 units
This course introduces the fundamental concepts necessary to understand the structure of polymers in the solid state. The structure of polymers will be discussed with focus on the amorphous, crystalline and liquid-crystalline state. One aim is to provide the student intuition about the organization of polymer molecules in the polymer's crystal structure. Attention will be given to the phenomenon of glass transition in amorphous polymers as well as the morphology and kinetics of crystal formation in semi-crystalline polymers. The second part of the course will focus on polymer multicomponent materials. Basic concepts of lattice models will be introduced and applied to predict the phase behavior of polymer blends. A last section will focus on microdomain formation in block copolymer materials.

27-357 Introduction to Materials Selection
Spring: 6 units
The objective of this course is to teach the fundamentals of materials science as related to metals and metal alloys. The topics to be covered include crystal structure, defects, diffusion, binary phase diagrams, microstructure and processing, elastic and plastic deformation, equations of elasticity for isotropic materials, deformation of single crystal, slip systems, the tensile test, Von Mises yield criterion, strengthening mechanisms, phase transformations in steels, microstructures of steels, fracture and toughness, creep and corrosion.

27-367 Selection and Performance of Materials
Spring: 6 units
This course teaches the selection methodologies for materials and processes for satisfaction of a design goal. Topics such as performance under load, shape effects, material properties (intrinsic and as influenced by processing) are discussed and applied so as to determine the fitness of use of materials for applications. Expanded topics include economics, codes and standards, environmental and safety regulations, professional ethics and life cycle analysis where applicable. The course incorporates a project where virtual teams work to provide material selection for a specific application problem. Prerequisites: 27-100
Prerequisite: 27-100.

27-399 Professional Development II
Fall: 1 unit
This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-401 MSE Capstone Course I
Fall: 12 units
This capstone course introduces the student to the methodology used for projects and team based research as practiced in the Materials Science and Engineering workplace. This is a course project that requires the knowledge relationship among processing, structure, and performance to address an important contemporary problem in materials science and engineering. Student taking this course will work in a team environment to complete a design project to resolve scientific and engineering issues relating to materials. Topics will be selected from a list or material problems or research concepts generated from industrial or academia. All research is expected to be original, and proper scientific ethics, and methodologies are enforced for the research and reports. Team participation and communication is an important issue and the presentation and reports must be technical and professional in structure. The course requires full project management and accounting for the research being conducted. On the topic selected, the work product is a report that provides clear definition of the problem being addressed, a methodology for the research, literature review, experimentation and reporting of findings, conclusions based on findings, and recommendations for future work. Prerequisites: 27-205 and 27-367.

27-402 MSE Capstone Course II
Spring: 12 units
This is the spring extension of 27-401. Teams or team members that have the industry agreement and that wish to continue their research project may do so in this course. As with 27-401, all research is expected to be original, and proper scientific ethics, and methodologies are enforced for the research and reports. Team participation and communication is an important issue and the presentation and reports must be technical and professional in structure. The course requires full project management and accounting for the research being conducted. On the topic selected, the work product is a report that provides clear definition of the problem being addressed, a methodology for the research, literature review, experimentation and reporting of findings, conclusions based on findings, and recommendations for future work. Prerequisites: 27-401
Prerequisite: 27-401.

27-405 Analysis and Prevention of Product Failures
Intermittent: 9 units
This course focuses on detailed case studies of failures such as recent structural collapses, heart valve fracture and other real world problems. A central focus of all analyses is the determination of the principal cause or causes of failure. These detailed causation determinations will involve techniques ranging from fault tree analysis to fractography by optical and scanning electron microscopy to stress analysis using finite element analysis. The current and potential future role of failure analysis and prevention in regulation and litigation will also be considered in detail, again using technology rich case studies. The final product is an analysis of a specific product failure that is both broadly based and technologically rigorous, combined with a strategy or strategies for its prevention. Prerequisites: 27-100 or permission of instructor.

27-410 Computational Techniques in Engineering
Spring: 9 units
This course develops the methods to formulate basic engineering problems in a way that makes them amenable to computational/numerical analysis. The course will consist of three major modules: basic programming skills, discretization of ordinary and partial differential equations, and numerical methods. These modules are followed by two modules taken from a larger list: Monte Carlo-based methods, molecular dynamics methods, image analysis methods, and so on. Students will learn how to work with numerical libraries and how to compile and execute scientific code written in Fortran-90 and C++. Students will be required to work on a course project in which aspects from at least two course modules must be integrated.
27-411 Introduction to Molecular Biomaterials
9 units
This course will cover structure-processing-property relationships in biomaterials for use in medicine. This course will focus on a variety of materials including natural biopolymers, synthetic polymers, and soft materials with additional treatment of metals and ceramics. Topics include considerations in molecular design of biomaterials, understanding cellular aspects of tissue-biometrics interactions, and the application of bulk and surface properties in the design of medical devices. This course will discuss practical applications of these materials in drug delivery, tissue engineering, biosensors, and other biomedical technologies. Cross-listed with 27-411.

27-421 Processing Design
Fall: 6 units
In this course, the concepts of materials and process design are developed, integrating the relevant fundamental phenomena in a case study of a process design. The course includes basic science and engineering as well as economic and environmental considerations. The case study is on environmentally acceptable sustainable steelmaking. Other case studies in materials processing could be used.

27-432 Electronic and Thermal Properties of Metals, Semiconductors and Related Devices
Fall even years: 9 units
This is Part I of a two-part course (Part II is 27-433) sequence concerned with the electrical, dielectric, magnetic and superconducting properties of materials. Students taking Part I will develop an in-depth understanding, based on the modern theories of solids, of the electrical, electronic and thermal properties of metals and semiconductors and the principles of operation of selected products and devices made from these materials. Overarching and interrelated topics will include elementary quantum and statistical mechanics, relationships between chemical bonds and energy bands in metals and semiconductors, the roles of phonons and electrons in the thermal conductivity of solids, diffusion and drift of electrons and holes, the important role of junctions in the establishment and control of electronic properties of selected metal- and semiconductor-based devices. Examples of commercial products will be introduced to demonstrate the application of the information presented in the text and reference books and class presentations. Additional topics will include microelectro-mechanical systems and nanoelectronics.

27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices
Fall odd years: 9 units
This is Part II of a two-part course sequence (Part I is 27-432) concerned with the electrical, dielectric, magnetic and superconducting properties of materials. Students taking Part II will develop an in-depth understanding, based on the modern theories of solids, of the dielectric, magnetic and superconducting properties of materials and the principles of operation of selected products and devices made from these materials. Topics will include relationships between chemical bonds and energy bands in dielectric and magnetic materials; polarization mechanisms in materials and their relationship to capacitance, piezoelectricity, ferroelectricity, and pyroelectricity; magnetization and its classification among materials; magnetic domains; soft and hard magnets; and the origin, theory and application of superconductivity. Examples of commercial products will be introduced to demonstrate the application of the information presented in the text and reference books and class presentations.

27-442 Deformation Processing
Intermittent: 9 units
A continuum analysis of plastic flow of isotropic and anisotropic (textured) materials will be applied to deformation processing. Crystallographic models of yielding and plastic flow will also be developed and used to characterize various industrial deformation processing techniques. Prerequisite: 27-441.

27-445 Structure, Properties and Performance Relationships in Magnetic Materials
Spring: 9 units
This course introduces the student to intrinsic properties of magnetic materials including magnetic dipole moments, magnetization, exchange coupling, magnetic anisotropy and magnetostriiction. This is followed by discussion of extrinsic properties including magnetic hysteresis, frequency dependent magnetic response and magnetic losses. This will serve as the basis for discussing phase relations and structure/properties relationships in various transition metal magnetic materials classes including iron, cobalt and nickel elemental magnets, iron-silicon, iron-nickel, iron-cobalt and iron phosphor. This will be followed by a discussion of rare earth permanent magnets, magnetic oxides, amorphous and nanocomposite magnets. Polymers used in Electromagnetic Interference (EMI) Absorbers applications will also be covered.

27-454 Supervised Reading
All Semesters
This course provides the opportunity for a detailed study of the literature on some subject under the guidance of a faculty member, usually but not necessarily in preparation for the Capstone Course, 27-401/402.

27-499 Professional Development III
Fall: 1 unit
This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics I, II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers, ceramics and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-510 Polymeric Biomaterials
Spring: 9 units
This is Part I of a two-part course sequence in Biomaterials. This introductory course will address basic and applied concepts of polymers as biomaterials. The students will be exposed to both fundamental synthetic mechanisms of polymers and their physical and chemical properties. Specific emphasis will be placed on biodegradation mechanisms, mechanical properties, and surface chemistry of polymer materials. Cellular interactions with various surfaces and immunological responses will be covered. Applications of biomaterials to be discussed include tissue engineering and artificial organs. Part II of this course will be offered in the fall and the focus will be on the principles, properties and applications of ceramics and metals as biomaterials.

27-511 Introduction to Molecular Biomaterials
Intermittent: 12 units
This course will cover structure-processing-property relationships in biomaterials for use in medicine. The vast majority of this course will focus on natural biopolymers, synthetic polymers, and soft materials with additional minor treatment of metals and ceramics. Topics include basic chemical principles, macromolecular design, processing, characterization, and biodegradation mechanisms associated with synthetic polymeric materials. Applications of these materials in drug delivery and tissue engineering will also be discussed. Knowledge gained during the course will be applied in a team-based project in which students must design a novel synthetic polymer to address a specific clinical need.

27-512 Diffraction Methods in Materials Science
Intermittent: 9 units
This is a specialized course in x-ray diffraction intended for advanced undergraduate students or graduate students. The theory and experimental techniques of diffraction in crystalline solids are introduced. Attention is given to the physical concepts behind crystal structure and diffraction, including the direct and reciprocal lattices, Bragg and Laue diffraction theories and structure-factor calculations. The experimental methods of x-ray and electron diffraction are presented, with emphasis on x-ray diffraction. Topics include the production and scattering of x-rays, factors affecting the scattered intensity, and techniques for obtaining and interpreting diffraction patterns. Pre-requisites: 33-107 (or equivalent), 27-201 or 27-211.

27-520 Special Topics: Tissue Engineering
12 units
This course will train students in advanced cellular and tissue engineering methods that apply physical, mechanical and chemical manipulation of materials in order to direct cell and tissue function. Students will learn the techniques and equipment of bench research including cell culture, immunofluorescent imaging, soft lithography, variable stiffness substrates, application/measurement of forces and other methods. Students will integrate classroom lectures and lab skills by applying the scientific method to develop a unique project while working in a team environment, keeping a detailed lab notebook and meeting mandated milestones. Emphasis will be placed on developing the written and oral communication skills required of the professional scientist. The class will culminate with a poster presentation session based on class projects. Prereqs: Cell biology and Biomaterials, or permission of instructor.
27-530 Advanced Physical Metallurgy
Fall: 9 units
The purpose of this course is to develop a fundamental understanding of the evolution of microstructure in engineering alloys and how desired mechanical and physical properties can be obtained by control of microstructure. The first part of the course considers phase stability, phase diagrams and the thermodynamics, mechanisms and kinetics of phase transformations. The second part of the course concerns property/microstructure relationships in engineering alloys and how the concepts covered in the first part of the course can be used to obtain the desired microstructures.

27-533 Principles of Growth and Processing of Semiconductors
Fall: 6 units
Development of a fundamental understanding of material principles governing the growth and processing of semiconductors. Techniques to grow and characterize bulk crystals and epitaxial layers are considered. The processing of semiconductors into devices and the defects introduced thereby are discussed. The roles of growth- and processing-induced defects in determining long term reliability of devices are examined.

27-542 Processing and Properties of Thin Films
Fall: 9 units
This course is designed to provide an introduction to the science and technology of thin films, with special emphasis on methods to produce thin films and relationships between growth conditions and thin film properties. Topics include (1) various methods of thin film production, such as evaporation, sputtering and chemical vapor deposition, (2) nucleation and growth processes, (3) dimensional, chemical, and structural characterization of thin films and (4) properties and applications, such as conductivity and thin film solar cells.

27-551 Properties of Ceramics and Glasses
Spring: 9 units
This course describes some of diverse properties of ceramics and glasses, with a focus on those relevant to modern engineering applications. It includes discussions of the underlying science of selected ceramic properties, such as thermal properties, including heat capacity and thermal expansion; mechanical properties, including strength, toughness, and environmental effects; electrical properties, including electronic and ionic conductivity; dielectric properties, including piezoelectricity and ferroelectricity; and optical properties, as they pertain to glasses and lasers. Numerous examples of current applications, such as lasers, sensors, fiber optics, multilayer capacitors, solid oxide fuel cells, or thermoelectrics, are discussed throughout the course to illustrate the engineering relevance of fundamental phenomena. This class will be co-taught with 27-751. Undergraduates taking the course will have separate homework and exams from the graduate students, and will be graded separately from the graduate students.

27-555 Materials Project I
Fall
This course is designed to give experience in individualized research under the guidance of a faculty member. The topic is selected by mutual agreement, and will give the student a chance to study the literature, design experiments, interpret the results and present the conclusions orally and in writing.

27-556 Materials Project II
Spring
Second semester of Materials Project. This course is designed to give experience in individualized research under the guidance of a faculty member. The topic is selected by mutual agreement, and will give the student a chance to study the literature, design experiments, interpret the results and present the conclusions orally and in writing.

27-561 Special Topics: Kinetics of Metallurgical Reactions and Processes
6 units
27-565 Nanostructured Materials
Intermittent: 9 units
Fall even years: This course is an introduction to nanostructured materials or nanomaterials. Nanomaterials are objects with sizes larger than the atomic or molecular length scales but smaller than microstructures with at least one dimension in the range of 1-100 nm. The physical and chemical properties of these materials are often distinctly different from bulk materials. This course introduces the basic thermodynamic concepts related to the phases, chemical activity and synthesis of nanomaterials including metallic, semiconductor, inorganic, liquid crystalline, polymeric and surfactant systems. The characterization of the structure of nanomaterials and their applications are also explored. At the end of the course, students should understand the relationship between the nanoscale structures, properties and performance of nanomaterials.

27-566 Special Topics in MSE
Fall and Spring: 9 units
This course is offered occasionally to present one or more topics, usually of timely or of practical engineering importance. Interested students should check with the Department to determine whether the course is being offered, and to obtain a syllabus if appropriate.

27-570 Molecular and Micro-scale Polymeric Biomaterials in Medicine
9 units
Fall and Spring: 9 units
This course will cover aspects of polymeric biomaterials in medicine from molecular principles to device scale design and fabrication. Topics include the chemistry, characterization, and processing of synthetic polymeric materials; cell-biomaterials interactions including interfacial phenomena, tissue responses, and biodegradation mechanisms; aspects of polymeric micro-systems design and fabrication for applications in medical devices. Recent advances in these topics will also be discussed. Pre-requisite: None.

27-582 Phase Transformations in Solids
Intermittent: 9 units
Spring even years: In this course the fundamental aspects of solid state phase transformations are presented. The nucleation (homogeneous and heterogeneous) and growth of diffusional and non-diffusional heterogeneous solid state transformations are discussed from the point of view of crystallography, thermodynamics and kinetics, as are the same aspects of homogeneous transformations. Details of such transformations as precipitation, cellular, atomic ordering, massive, spinodal decomposition, displacive, etc. are discussed with specific examples from the Materials Science literature.

27-591 Mechanical Behavior of Materials
Intermittent: 9 units
Spring odd years: Fundamentals of stress and strain. Linear elastic behavior. Tensile testing and yield criteria. Relationships between stress and strain for the case of plastic deformation. Theoretical strength. Tensile tests of single crystals and the idea of a slip system. Shear stress versus shear strain curves for single crystals and the effects of crystal orientation, temperature, atoms in solid solution and precipitates on the shapes of such curves. Taylor’s connection between tensile curves of single crystals and those of polycrystalline samples. Dislocations and plastic deformation. Strengthening mechanisms including solid-solution strengthening, strengthening by precipitates, work hardening and grain size effects on strength. Approaches to quantifying the fracture resistance of materials, including the Griffith approach, the energy release rate approach and the stress intensity factor approach. Crack tip behavior including stresses and strains at crack tips and the plastic zone. Fracture mechanisms including ductile fracture, cleavage fracture and intergranular fracture. The fracture of highly brittle materials. Time permitting fatigue and creep of materials will be discussed.

27-592 Solidification Processing
Intermittent: 9 units
Spring odd years: The goal of this course is to enable the student to solve practical solidification processing problems with the application of solidification theory. The objectives of this course are to: (1) Develop solidification theory so that the student can understand predict solidification structure; (2) Develop a strong understanding of the role of heat transfer in castings; (3) Develop an appreciation for the strengths and weaknesses of a variety of casting processes. The first half of the course will be theoretical, covering nucleation, growth, instability, solidification microstructure: cells, dendrites, eutectic and peritectic structures, solute redistribution, inclusion formation and separation, defects and heat transfer problems. The second part of the course will be process oriented and will include conventional and near net shape casting, investment casting, rapid solidification and spray casting where the emphasis will be on process design to avoid defects.
27-594 Electrochemical Degradation of Materials
Intermittent: 9 units
This course is designed to provide an overview of how metallic material degrade through electrochemical processes in various environments. This will include aqueous corrosion of active and passive alloys and high-temperature oxidation. The fundamentals of electrochemical cells, electrochemical potentials and electrode kinetics will be introduced and used to predict corrosion rates in various case studies. Prerequisite: 27-215.

27-709 Introduction to Molecular Biomaterials
12 units
This course will cover structure-processing-property relationships in biomaterials for use in medicine. This course will focus on a variety of materials including natural biopolymers, synthetic polymers, and soft materials with additional treatment of metals and ceramics. Topics include considerations in molecular design of biomaterials, understanding cellular aspects of tissue-biomaterials interactions, and the application of bulk and surface properties in the design of medical devices. This course will discuss practical applications of these materials in drug delivery, tissue engineering, biosensors, and other biomedical technologies. This course is a project-based option for graduate students that is taught concurrently with 42-411.

27-718 Soft Materials
Fall: 12 units
The emphasis in this course will be on the emerging unifying physical principles that explain the macroscopic properties of a wide variety of soft materials, e.g., colloids, liquid crystals, surfactants, polymers, and biological structures. At the end of the course, students should understand the concepts, experimental techniques, and open questions in the field. The course is interdisciplinary, and it is expected that enrollment will cover a wide spectrum of students. Therefore, the essential concepts will be taught as necessary. Prerequisites: Graduate standing or permission of instructor.

27-721 Processing Design
Fall: 6 units
In this course, the concepts of materials and process design are developed, integrating the relevant fundamental phenomena in a case study of a processing design. The course includes basic science and engineering as well as economic and environmental considerations. The case study is on environmentally acceptable sustainable steelmaking. Other case studies in materials processing could be used.

27-756 Masters Project
All Semesters
Individual research project, including laboratory, theoretical, library or design work followed by a written or oral report on the work accomplished.

27-766 Diffusion in Materials
Fall: 6 units
This course is designed to allow the student to become familiar with the fundamental principles diffusion in solid materials. The course will include the treatment of diffusion from an atomic scale to micro-structural scales in metals, ceramics, glasses and polymers. In addition, the student will develop skills and methodologies necessary to apply mathematical methods to solve differential equations of relevance to diffusion problems including separation of variables, Laplace transforms ad Green’s functions. An introduction will be given to the application of numerical solutions. Where appropriate, examples will be taken from problems related to the design of components and the processing and performance of materials.

27-788 Defects in Materials
Fall: 6 units
This course addresses the fundamental properties of defects in crystalline solids, as well as their effects on properties and behavior of materials. Primary attention is devoted to point and line defects. Somewhat less comprehensive coverage is given to extended defects, including grain boundaries, interphase boundaries and surfaces. 4 hrs. lec.

27-791 Mechanical Behavior of Materials
Spring: 12 units
The intent of the course is to introduce various measures indicative of the performance of materials in applications. Properties often used in selecting materials will be introduced, and connections between these properties and microstructure will be developed. Mechanical properties are emphasized in this course. 4 hrs. lec.

27-796 Structure of Materials
6 units
The skills and ideas necessary to understand the atomic structure of crystalline materials are presented. The objective is for the student to be able to describe crystal structures based on their symmetry (Bravais lattices, point groups and space groups) as well as packing configurations and to understand how diffraction is used to experimentally probe crystal structures.

27-797 Bonding of Materials
6 units
Models for cohesive forces in crystals are reviewed; both quantitative and phenomenological descriptions of secondary, ionic, metallic, and covalent bonds are discussed. A band structure language is developed starting from free electron and LCAO models of metals and covalently bonded crystals, respectively. 4 hrs lecture.

27-798 Thermodynamics I
Fall: 6 units
Course Description: The laws, concepts, and definitions of classical thermodynamics as well selected relationships that matter exhibits will be covered and applied to gas, liquid and crystalline systems. Concepts and classifications of thermodynamic systems, variables and relationships will be presented and discussed. General criteria and conditions for equilibrium will be developed and applied. The basic concepts of statistical thermodynamics will be introduced and applied to the interpretation of entropy. Alternate statistical formulations will be introduced and compared.

27-799 Thermodynamics II
Fall: 6 units
Course Description: The course will apply thermodynamic fundamentals covered in Thermodynamics I (27-780) to unary and to multi-component materials systems. The course will also cover phase diagrams, predominance diagrams, chemical reactions and thermodynamics of surfaces.

Mathematical Sciences Courses

21-101 Freshman Mathematics Seminar
Fall: 3 units
This course is offered in the Fall semester for first semester freshmen interested in majoring in mathematics. Topics vary from year to year. Recent topics have included difference equations, convexity, and fractals. 3 hrs. lec.

21-105 Pre-Calculus
Fall: 9 units
Review of basic concepts, logarithms, functions and graphs, inequalities, polynomial functions, complex numbers, and trigonometric functions and identities. 3 hrs lec., 1 hr rec.

21-110 Problem Solving in Recreational Mathematics
Spring: 9 units
The emphasis is on learning to solve problems in elementary mathematics. Topics may vary among offerings of the course, but typically include puzzles, algebraic problems, number theory, and graph theory. 3 hrs. lec.

21-111 Calculus I
All Semesters: 10 units
Review of basic algebra, functions, limits, derivatives of algebraic, exponential and logarithmic functions, curve sketching, applications with emphasis on economic models. Successful completion of 21-111 and 21-112 entitles a student to enroll in any mathematics course for which 21-120 is a prerequisite. 3 hrs. lec., 2 hrs. rec.

21-112 Calculus II
All Semesters: 10 units
Indefinite integral, definite integral and applications, techniques of integration, trigonometric functions, functions of several variables, partial derivatives, maximum-minimum problems, Lagrange multipliers, geometric series, Newton’s method, applications. Successful completion of 21-111 and 21-112 entitles a student to enroll in any mathematics course for which 21-120 is a prerequisite. 3 hrs. lec., 2 hrs. rec. Prerequisite: 21-111.

21-115 Differential Calculus
Summer: 5 units
Functions, limits, derivatives, curve sketching, Mean Value Theorem, trigonometric functions, related rates, linear and quadratic approximations, maximum-minimum problems.
21-120 Differential and Integral Calculus
All Semesters: 10 units
Functions, limits, derivatives, logarithmic, exponential, and trigonometric functions, inverse functions; L'Hopital's Rule, curve sketching, Mean Value Theorem, related rates, linear and quadratic approximations, maximum-minimum problems, inverse functions, definite and indefinite integrals, and hyperbolic functions; applications of integration, integration by substitution and by parts. 3 hrs lec., 2 hrs rec.

21-122 Integration, Differential Equations and Approximation
All Semesters: 10 units
Integration by trigonometric substitution and partial fractions; arclength; improper integrals; Simpson's and Trapezoidal Rules for numerical integration; separable differential equations, first order linear differential equations, homogeneous second order linear differential equations with constant coefficients, series solution, Newton's method, Taylor's Theorem including a discussion of the remainder, sequences, series, power series. 3 hrs lec., 2 hrs rec. Prerequisites: 21-120 or 21-112.

21-124 Calculus II for Biologists and Chemists
Spring: 10 units
This is intended as a second calculus course for biology and chemistry majors. It uses a variety of computational techniques based around the use of MATLAB or a similar system. In addition to major topics from calculus and linear algebra there is a substantial statistical component in the course. 3 hours lecture, 2 hours recitation. Prerequisite: 21-112 or 21-120.

21-125 Maple Lab
Intermittent: 3 units
An introduction to the symbolic programming package Maple using mathematical topics chosen from calculus and matrix algebra. Recommended to accompany any calculus course beyond 21-120 Differential and Integral Calculus. 1 hr lec.

21-126 Introduction to Mathematical Software
Fall and Spring: 3 units
This course provides an introduction to the use of several software packages, which are useful to mathematics students. Among the packages are Maple and Mathematica for symbolic computing, TeX and LaTeX for mathematical documents, and Matlab for numerical computing. The course will also introduce the mathematical facilities built into spreadsheets such as Excel. The aim of the course is to provide the student with some basic skills in the use of this software without attempting complete coverage. A deeper knowledge of the software will be easy to obtain after completing this course. There are no prerequisites for the course, other than basic computer literacy and a knowledge of elementary mathematics. It is suggested that the course should be taken during the first two years of undergraduate studies.

21-127 Concepts of Mathematics
All Semesters: 10 units
This course introduces the basic concepts, ideas and tools involved in doing mathematics. As such, its main focus is on presenting informal logic, and the methods of mathematical proof. These subjects are closely related to the application of mathematics in many areas, particularly computer science. Topics discussed include a basic introduction to elementary number theory, induction, the algebra of sets, relations, equivalence relations, congruences, partitions, and functions, including injections, surjections, and bijections. A prerequisite for 15-211. 3 hrs lec., 2 hrs rec.

21-201 Undergraduate Colloquium
Fall and Spring: 1 unit
All mathematics majors meet for one hour each week to hear discussions on current research by faculty or students, presentations on mathematics from mathematicians outside academia, and expository talks on selected mathematical topics not part of the usual curricula. Also will include topics of special interest to undergraduates such as preparation for graduate school.

21-228 Discrete Mathematics
Spring: 9 units
The techniques of discrete mathematics arise in every application of mathematics, which is not purely continuous, for example in computer science, economics, and general problems of optimization. This course introduces two of the fundamental areas of discrete mathematics: enumeration and graph theory. The introduction to enumeration includes permutations, combinations, and topics such as discrete probability, combinatorial distributions, recurrence relations, generating functions, Ramsey's Theorem, and the principle of inclusion and exclusion. The introduction to graph theory includes topics such as paths, walks, connectivity, Eulerian and Hamilton cycles, planar graphs, Euler's Theorem, graph coloring, matchings, networks, and trees. 3 hrs lec., 1 hr rec. Prerequisite: 21-127.

21-235 Mathematical Studies Analysis I
Fall: 10 units

21-236 Mathematical Studies Analysis II
Spring: 10 units

21-237 Mathematical Studies Algebra I
Fall: 10 units
An honors version of 21-373 Algebraic structures for students of greater aptitude and motivation. Abstract algebra is the study of algebraic systems by the axiomatic method, and it is one of the core areas of modern mathematics. This course is a rigorous and fast-paced introduction to the basic objects in abstract algebra. Topics to be covered include: Homomorphisms. Subgroups, cosets, Lagrange's Theorem. Conjugation. Normal subgroups, quotient groups, first isomorphism theorem. Automorphisms, the automorphism group, characteristic subgroups. Group actions, Cauchy's Theorem, Sylow's theorem. Normalisers and centralisers, class equation, finite p-groups. Dihedral and alternating groups. The second and third isomorphism theorems. Simple groups, statement of Jordan-Hölder theorem, semidirect product of groups. Subrings, ideals, quotient rings, first isomorphism theorem. Polynomial rings. Zorn's Lemma. Prime and irreducible elements. PID's and UFD's. Noetherian domains. Hilbert Basis Theorem. Gauss' Lemma. Eisenstein criterion. Field of fractions of an integral domain. k a field implies k[x] a PID, R a UFD implies R[x] a UFD. Finite fields and applications. 3 hrs lec. Prerequisites: 21-127 and 21-269.
21-238 Mathematical Studies Algebra II
Spring: 10 units
An honors version of 21-341 Linear Algebra for students of greater aptitude and motivation. Linear algebra is a crucial tool in pure and applied mathematics. This course aims to introduce the main ideas at a high level of rigour and generality. The course starts with the study of (potentially) infinite-dimensional vector spaces over an arbitrary field, continues with the theory of modules (where the role of the field is now played by an arbitrary ring), and concludes with the development of real and complex inner product spaces. Topics to be covered include: Review of fields. Review of Zorn’s Lemma. Vector spaces (possibly in finite dimensional) over an arbitrary field. Independent sets, bases, existence of a basis, exchange lemma, dimension. Linear transformations, dual space. Multilinear maps, tensor product, exterior power, determinant of a transformation. Eigenvectors, eigenvalues, characteristic and minimal polynomial of a transformation, Cayley-Hamilton theorem. Review of commutative rings. R-modules. Sums and quotients of modules. Free modules. Structure theorem for fg modules over a PID and applications (Jordan and rational canonical form, structure theory of fg abelian groups). Review of real and complex numbers. Real and complex inner product spaces. Orthonormal sets, orthonormal bases, Gram-Schmidt. Examples: F^n and (l^2(F) for F = R; C. Operators: Symmetric/Hermitian and Orthogonal/Unitary operators. Spectral theorem. Quadratic forms. Singular value decomposition. Possible additional topics (time permitting): applications to combinatorics, category theory, representations of finite groups, normed spaces. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-237 and 21-242.

21-240 Matrix Algebra with Applications
Fall and Spring: 10 units
Vectors and matrices, the solution of linear systems of equations, vector spaces and subspaces, orthogonality, determinants, real and complex eigenvalues and eigenvectors, linear transformations. The course is intended for students in Economics, Statistics, Information Systems, and it will focus on topics relevant to these fields. 3 hrs. lec., 1 hr. rec.

21-241 Matrices and Linear Transformations
Fall and Spring: 10 units
A first course in linear algebra intended for scientists, engineers, mathematicians and computer scientists. Students will be required to write some straightforward proofs. Topics to be covered: complex numbers, real and complex vectors and matrices, rowspace and columnspace of a matrix, rank and nullity, solving linear systems by row reduction of a matrix, inverse matrices and determinants, change of basis, linear transformations, inner product of vectors, orthonormal bases and the gram-schmidt process, eigenvectors and eigenvalues, diagonalization of a matrix, symmetric and orthogonal matrices. 3 hrs. lec., 1 hr. rec.

21-242 Matrix Theory
Fall and Spring: 10 units
An honors version of 21-241 (Matrix Algebra and Linear Transformations) for students of greater aptitude and motivation. More emphasis will be placed on writing proofs. Topics to be covered: complex numbers, real and complex vectors and matrices, rowspace and columnspace of a matrix, rank and nullity, solving linear systems by row reduction of a matrix, inverse matrices and determinants, change of basis, linear transformations, inner product of vectors, orthonormal bases and the gram-schmidt process, eigenvectors and eigenvalues, diagonalization of a matrix, symmetric and orthogonal matrices, hermitian and unitary matrices, quadratic forms. 3 hrs. lec., 1 hr. rec.

21-256 Multivariate Analysis
Fall and Spring: 9 units
This course is designed for students in Economics or Business Administration. Matrix algebra: vectors, matrices, systems of equations, dot product, cross product, lines and planes. Optimization: partial derivatives, the chain rule, gradient, unconstrained optimization, constrained optimization (Lagrange multipliers and the Kuhn-Tucker Theorem). Improper integrals. Integration: iterated integrals, probability applications, triple integrals, change of variables. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-120 or 21-112.

21-257 Models and Methods for Optimization
All Semesters: 9 units
Introduces basic methods of operations research and is intended primarily for Business Administration and Economics majors. Review of linear systems; linear programming, including the simplex algorithm, duality, and sensitivity analysis; the transportation problem; the critical path method; the knapsack problem, traveling salesperson problem, and an introduction to set covering models. 3 hrs. lec., 1 hr. rec.
Prerequisites: 06-262 or 19-202 or 21-240 or 21-241 or 21-256 or 21-341.

21-258 Multidimensional Calculus
Fall and Spring: 10 units
Pending Fall 2011 approval by MCS College Council. A serious introduction to multidimensional calculus that makes use of matrices and linear transformations. The course is intended for students in Economics, Statistics, Information Systems, and it will focus on topics relevant to these fields. 3 hrs. lec., 1 hr. rec.

21-259 Calculus in Three Dimensions
Fall and Spring: 9 units
Vectors, lines, planes, quadratic surfaces, polar, cylindrical and spherical coordinates, partial derivatives, directional derivatives, gradient, divergence, curl, chain rule, maximum-minimum problems, multiple integrals, parametric surfaces and curves, line integrals, surface integrals, Green-Gauss theorems. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-120 or 21-112.

21-260 Differential Equations
Fall: 9 units
Prerequisite: 21-212.

21-261 Introduction to Ordinary Differential Equations
All Semesters: 10 units
A first course in ordinary differential equations intended primarily for math majors and for those students interested in a more conceptual treatment of the subject. One of the goals of this course is to prepare students for upper level courses on differential equations, mathematical analysis and applied mathematics. Students will be required to write rigorous arguments. Topics to be covered: Ordinary differential equations: first and second order equations, applications, Laplace transform, systems of linear ordinary differential equations; systems of nonlinear ordinary differential equations, equilibrium and stability. 3 hrs. lec., 1 hr. rec.
Prerequisite: 21-122.

21-268 Vector Analysis
Fall and Spring: 10 units
Pending Fall 2011 approval by MCS College Council. This is a first course for those considering majoring or minoring in Mathematics. This course aims to introduce the main ideas at a high level of rigour and generality. The course starts with the theory of modules (where the role of the field is now played by an arbitrary ring), and concludes with the development of real and complex inner product spaces. Topics to be covered: Review of finite-dimensional vector spaces over an arbitrary field, independent sets, bases, existence of a basis, exchange lemma, dimension. Linear transformations, dual space. Multilinear maps, tensor product, exterior power, determinant of a transformation. Eigenvectors, eigenvalues, characteristic and minimal polynomial of a transformation, Cayley-Hamilton theorem. Review of commutative rings. R-modules. Sums and quotients of modules. Free modules. Structure theorem for finite-dimensional vector spaces over a PID and applications (Jordan and rational canonical form, structure theory of abelian groups). Review of real and complex numbers. Real and complex inner product spaces. Orthonormal sets, orthonormal bases, Gram-Schmidt. Examples: F^n and (l^2(F) for F = R; C. Operators: Symmetric/Hermitian and Orthogonal/Unitary operators. Spectral theorem. Quadratic forms. Singular value decomposition. Possible additional topics (time permitting): applications to combinatorics, category theory, representations of finite groups, normed spaces. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-237 and 21-242.

21-269 Vector Analysis
Spring: 10 units
Pending Fall 2011 approval by MCS College Council. This is a first course for those considering majoring or minoring in Mathematics. This course aims to introduce the main ideas at a high level of rigour and generality. The course starts with the theory of modules (where the role of the field is now played by an arbitrary ring), and concludes with the development of real and complex inner product spaces. Topics to be covered: Review of finite-dimensional vector spaces over an arbitrary field, independent sets, bases, existence of a basis, exchange lemma, dimension. Linear transformations, dual space. Multilinear maps, tensor product, exterior power, determinant of a transformation. Eigenvectors, eigenvalues, characteristic and minimal polynomial of a transformation, Cayley-Hamilton theorem. Review of commutative rings. R-modules. Sums and quotients of modules. Free modules. Structure theorem for finite-dimensional vector spaces over a PID and applications (Jordan and rational canonical form, structure theory of abelian groups). Review of real and complex numbers. Real and complex inner product spaces. Orthonormal sets, orthonormal bases, Gram-Schmidt. Examples: F^n and (l^2(F) for F = R; C. Operators: Symmetric/Hermitian and Orthogonal/Unitary operators. Spectral theorem. Quadratic forms. Singular value decomposition. Possible additional topics (time permitting): applications to combinatorics, category theory, representations of finite groups, normed spaces. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-237 and 21-242.

21-270 Introduction to Mathematical Finance
Fall and Spring: 10 units
This is a first course for those considering majoring or minoring in Computational Finance. The theme of this course is pricing derivative securities by replication. The simplest case of this idea, static hedging, is used to discuss net present value of a non-random cash flow, internal rate of return, and put-call option parity. Pricing by replication is then considered in a one-period random model. Risk-neutral probability measures, the Fundamental Theorems of Asset Pricing, and an introduction to expected utility maximization and mean-variance analysis are presented in this model. Finally, replication is studied in a multi-period binomial model. Within this model, the replicating strategies for European and American options are determined. 3 hours lecture.
Prerequisites: 21-111 or 21-120.
21-292 Operations Research I
Spring: 9 units
Operations research offers a scientific approach to decision making, most commonly involving the allocation of scarce resources. This course develops some of the fundamental methods used. Linear programming: the simplex method and its linear algebra foundations, duality, post-optimality and sensitivity analysis; the transportation problem; the critical path method; non-linear programming methods. 3 hrs. lec., 1 hr. rec.
Prerequisites: 21-122 or 21-132 and 21-241 or 21-341.

21-295 Putnam Seminar
Fall: 3 units
A problem solving seminar designed to prepare students to participate in the annual William Lowell Putnam Mathematical Competition. Students solve and present their solutions to problems posed.

21-296 Millennium Problems Seminar
Intermittent: 3 units
This seminar course will discuss some of the most important unsolved problems of mathematics (as deemed in 2000 by an international committee of mathematicians): The Riemann Hypothesis; Yang-Mills Theory and the Mass Gap Hypothesis; the P. vs. NP Problem; smoothness of solutions of the Navier-Stokes Equations; the Hodge Conjecture; the Birch and Swinnerton-Dyer Conjecture. If the time allows, the Poincare conjecture will also be discussed. 1 hr. lec.

21-300 Basic Logic
Fall: 9 units
Propositional and predicate logic: Syntax, proof theory and semantics up to completeness theorem, Lowenheim Skolem theorems, and applications of the compactness theorem. 3 hrs. lec.
Prerequisites: (21-127) and (21-484 or 15-251 or 21-132 or 21-228 or 21-373).

21-301 Combinatorics
Fall: 9 units
A major part of the course concentrates on algebraic methods, which are relevant in the study of error correcting codes, and other areas. Topics covered in depth include permutations and combinations, generating functions, recurrence relations, the principle of inclusion and exclusion, and the Fibonacci sequence and the harmonic series. Additional topics may include existence proofs, partitions, finite calculus, generating combinatorial objects, Polya theory, codes, probabilistic methods. 3 hrs. lec.
Prerequisites: (21-122) and (21-228 or 15-251).

21-320 Symbolic Programming Methods
Intermittent: 9 units
The objective of this course is to learn to program in Maple, a powerful symbolic mathematics package available on many platforms at Carnegie Mellon. After learning what Maple can do with the commands provided with the package, students will learn to develop their own Maple functions to accomplish extended mathematical computations. Grades in the course will be based mostly on project work. Projects may come from any relevant field and may be graphical, numerical, or symbolic or all three. The course will involve online demonstrations in most classes. 3 hrs. lec.

21-325 Probability
Fall: 9 units
This course focuses on the understanding of basic concepts in probability theory and illustrates how these concepts can be applied to develop and analyze models from diverse applications as well as preparing the interested student for advanced work in these areas. The course will cover core concepts such as probability spaces, random variables, random vectors, multivariate densities, distributions, expectations, sampling and simulation; independence; conditioning, conditional distributions and expectations; limit theorems such as the strong law of large numbers and the central limit theorem; as well as additional topics such as large deviations, random walks and Markov chains, as time permits. 3 hours lecture.
Prerequisites: 21-122 and 21-259.

21-329 Set Theory
Spring: 9 units
Set theory was invented about 110 years ago by George Cantor as an instrument to understand infinite objects and to compare different sizes of infinite sets. Since then set theory has come to play an important role in several branches of modern mathematics, and serves as a foundation of mathematics. Contents: Basic properties of natural numbers, countable and uncountable sets, construction of the real numbers, some basic facts about the topology of the real line, cardinal numbers and cardinal arithmetic, the continuum hypothesis, well ordered sets, ordinal numbers and transfinite induction, the axiom of choice, Zorn's lemma. Optional topics if time permits: Infinitary combinatorics, filters and large cardinals, Borel and analytic sets of reals. 3 hrs. lec.
Prerequisite: 21-127.

21-341 Linear Algebra
Fall and Spring: 9 units
21-341 Linear Algebra. A mathematically rigorous treatment of Linear Algebra over an arbitrary field. Topics studied will include abstract vector spaces, linear transformations, determinants, eigenvalues, eigenvectors, inner products, invariant subspaces, canonical forms, the spectral theorem and the singular value decomposition. 21-241 required; 21-373 recommended. 3 hrs. lec.
Prerequisite: 21-241.

21-350 History of Mathematics
Intermittent: 9 units
Mathematics has a long and interesting history, and there is much insight into both mathematics and history to be gained from its study. The emphasis here will be on learning the mathematics with the added value of appreciating it in historical context. Selected topics may range from early number systems, the development of geometry, the emergence of the ideas of analysis, through to the origins of modern set theory. 3 hrs. lec.

21-355 Principles of Real Analysis I
Fall and Spring: 9 units
Prerequisites: 21-122 and 21-127.

21-356 Principles of Real Analysis II
Spring: 9 units
Topology in metric spaces, specialization to finite dimensional normed linear spaces. Vector differential calculi: continuity and the total derivative, partial derivatives, directional derivatives, gradients, Jacobians, the chain rule, implicit function theorem. Vector integral calculus: double and triple integrals, arclength and surface area, line integrals, Green's Theorem, surface integrals, Divergence and Stokes Theorems. If time permits: trigonometric series, Fourier series for orthonormal bases, minimization of square error. 3 hours lecture.
Prerequisites: 21-241 and 21-259 and 21-355.

21-365 Projects in Applied Mathematics
Intermittent: 9 units
This course provides students with an opportunity to solve problems posed by area companies. It is also designed to provide experience working as part of a team to solve problems for a client. The background needed might include linear programming, simulation, data analysis, scheduling, numerical techniques, etc.

21-366 Topics in Applied Mathematics
Intermittent: 9 units
Typically courses that might be offered from time to time are game theory, non-linear optimization, and dynamic programming. Prerequisites will vary with topic. 3 hrs. lec.
Prerequisite: 21-127.
21-369 Numerical Methods
Fall and Spring: 9 units
This course provides an introduction to the use of computers to solve scientific problems. Methods for the computational solution of linear algebra systems, nonlinear equations, the interpolation and approximation of functions, differentiation and integration, and ordinary differential equations. Analysis of roundoff and discretization errors and programming techniques. 3 hrs. lec.
Prerequisites: 15-110 and 21-259.

21-370 Discrete Time Finance
Fall: 9 units
This course introduces the Black-Scholes option pricing formula, shows how the binomial model provides a discretization of this formula, and uses this connection to fit the binomial model to data. It then sets the stage for Continuous-Time Finance by discussing in the binomial model the mathematical technology of filtrations, martingales, Markov processes and risk-neutral measures. Additional topics are American options, expected utility maximization, the Fundamental Theorems of Asset Pricing in a multi-period setting, and term structure modeling, including the Heath-Jarrow-Morton model. Students in 21-370 are expected to read and write proofs. 3 hours lecture.
Prerequisites: (21-270 or 70-492) and (21-256 or 21-259)

21-371 Functions of a Complex Variable
Intermittent: 9 units
This course provides an introduction to one of the basic topics of both pure and applied mathematics and is suitable for those with both practical and theoretical interests. Algebra and geometry of complex numbers; complex differentiation and integration. Cauchy’s theorem and applications; conformal mapping; applications. 3 hrs. lec.
Prerequisites: 21-259 and 21-260.

21-372 Partial Differential Equations
Spring: 9 units
This course provides an introduction to partial differential equations and is recommended for majors in mathematics, physical science, or engineering. Boundary value problems on an interval, Fourier series, uniform convergence, the heat, wave, and potential equations on bounded domains, general theory of eigenfunction expansion, the Fourier integral applied to problems on unbounded domains, introduction to numerical methods. 3 hrs. lec.
Prerequisites: 21-259 and 21-260.

21-373 Algebraic Structures
Fall and Spring: 9 units
Prerequisites: (21-241 or 21-341) and 21-127.

21-374 Field Theory
Spring: 9 units
The purpose of this course is to provide a successor to Algebraic Structures, with an emphasis on applications of groups and rings within algebra to some major classical problems. These include constructions with a ruler and compass, and the solvability or unsolvability of equations by radicals. It also offers an opportunity to see group theory and basic ring theory "in action", and introduces several powerful number theoretic techniques. The basic ideas and methods required to study finite fields will also be introduced. These ideas have recently been applied in a number of areas of theoretical computer science including primality testing and cryptography. 3 hrs. lec.
Prerequisite: 21-373.

21-375 Topics in Algebra
Intermittent: 9 units
Typical of courses which are offered from time to time are Boolean algebras, algebraic theory of semigroups, rings and ideals, number theory, inequalities. 3 hrs. lec.
Prerequisite: 21-373.

21-393 Operations Research II
Fall: 9 units
Building on an understanding of Linear Programming developed in 21-292 Operations Research I, this course introduces more advanced topics. Integer programming, including cutting planes and branch and bound. Dynamic programming. An introduction to Combinatorial Optimization including optimal spanning trees, shortest paths, the assignment problem and max-flow/min-cut. The traveling salesman problem and NP-completeness. An important goal of this course is for the student to gain experience with the process of working in a group to apply operations research methods to solve a problem. A portion of the course is devoted to a group project based upon case studies and the methods presented. Prerequisites: 21-292 and (21-228 or 15-251) required. 36-410 recommended. 3 hrs. lec.
Prerequisites: (21-228 or 15-251) and (21-292).

21-420 Continuous-Time Finance
Spring: 9 units
This course begins with Brownian motion, stochastic integration, and Ito’s formula from stochastic calculus. This theory is used to develop the Black-Scholes option pricing formula and the Black-Scholes partial differential equation. Additional topics may include models of credit risk, simulation, and expected utility maximization. 3 hours lecture.
Prerequisites: (21-260 or 18-202) and 21-370 and (36-225 or 21-325 or 36-217).

21-440 Selected Topics in Algebra
Intermittent: 9 units
Typical of courses which are offered from time to time are Boolean algebras, algebraic theory of semigroups, rings and ideals, number theory, inequalities. 3 hrs. lec.
Prerequisite: 21-373.

21-441 Number Theory
Fall: 9 units
Number theory deals with the integers, the most basic structures of mathematics. It is one of the most ancient, beautiful, and well-studied branches of mathematics, and has recently found surprising new applications in communications and cryptography. Course contents: Structure of the integers, greatest common divisors, prime factorization. Modular arithmetic, Fermat’s Theorem, Chinese Remainder Theorem. Number theoretic functions, e.g. Euler’s function, Mobius functions, and identities. Diophantine equations, Pell’s Equation, continued fractions. Modular polynomial equations, quadratic reciprocity. 3 hrs. lec.
Prerequisites: 21-241 and 21-127 and 21-373.

21-450 Topics in Geometry
Intermittent: 9 units
Typical of courses, which are offered from time to time are convex sets, projective geometry, and classical geometry. 3 hrs. lec.
Prerequisite: 21-356.

21-465 Topology
Fall: 9 units
Prerequisites: 21-356 and 21-373.

21-467 Differential Geometry
9 units
This course will provide a thorough and rigorous introduction to differential geometry on manifolds. Contents: Differentiable manifolds; tangent spaces; vector fields and n-forms; integral curves; cotangent vectors; tensors; Riemanian metrics; connection; parallel transport; geodesics and convex neighborhoods; sectional, Ricci, scalar curvatures; tensors on Riemannian manifolds; Lie groups; homogeneous spaces. 3 hrs. lec.
Prerequisites: 21-356 and 21-373.

21-470 Selected Topics in Analysis
Intermittent: 9 units
Typical of courses, which are offered from time to time are elliptic curves, commutative algebra, and theory of Boolean functions. 3 hrs. lec.
Prerequisite: 21-236 or (21-241 and 36-225).
21-476 Ordinary Differential Equations
Intermittent: 9 units
Review of solution techniques, modeling techniques, existence and uniqueness, numerical procedures, linear equations and systems, special functions, autonomous non-linear systems, qualitative techniques. 3 hrs. lec.
Prerequisites: 21-241 and 21-260.

21-484 Graph Theory
Spring: 9 units
Graph theory uses basic concepts to approach a diversity of problems and nontrivial applications in operations research, computer science and other disciplines. It is one of the very few mathematical areas where one is always close to interesting unsolved problems. Topics include graphs and subgraphs, trees, connectivity, Euler tours and Hamilton cycles, matchings, graph colorings, planar graphs and Euler’s formula, directed graphs, network flows, counting arguments, and graph algorithms. 3 hrs. lec.
Prerequisites: (21-228 or 21-301 or 15-251) and (21-241 or 21-341).

21-499 Undergraduate Research Topic
Fall: 9 units
This course affords undergraduates to pursue elementary research topics in the area of expertise of the instructor.
Prerequisite: 21-260.

21-590 Practicum
All Semesters
Students in this course gain experience with the application of mathematical models to business and/or industrial problems during an internship. The internship is set up by the student in consultation with a faculty member. The students must also have a mentor at the firm providing the internship, who together with the faculty member develops a description of the goals of the internship. The internship must include the opportunity to learn about problems which have mathematical content.

21-599 Undergraduate Reading and Research
Fall and Spring
Individual reading courses or projects in mathematics and its applications. Prerequisites and units to be negotiated with individual instructors.

21-600 Mathematical Logic I
Fall: 12 units
The study of formal logical systems, which model the reasoning of mathematics, scientific disciplines, and everyday discourse. Propositional Calculus and First-order Logic. Syntax, axiomatic treatment, derived rules of inference, proof techniques, computer-assisted formal proofs, normal forms, consistency, independence, semantics, soundness, completeness, Löwenheim-Skolem Theorem, compactness, equality. 3 hrs. lec.
Prerequisites: 21-132 or 21-228 or 21-373 or 21-484.

21-602 Introduction to Set Theory I
Fall: 12 units
First order definability and the Zermelo-Fraenkel axioms; cardinal arithmetic, ordered sets, well-ordered sets (axiom of choice), transfinite induction, the filter of closed unbounded sets (Fodor, Ulm and Solovay’s theorems), Delta systems, basic results in partition calculus (e.g., Ramsey’s Theorem and the Erdos-Rado Theorem); small to medium large cardinals; applications to general topology (e.g., Alexandroff’s conjecture), and the basic ideas of descriptive set theory. The independence of Suslin conjecture from the usual axioms. Godel’s axiom of constructibility. Time permitting, the Galvin-Hajnal-Shelah inequality will be proved. 3 hrs. lec.

21-603 Model Theory I
Intermittent: 12 units
Similarity types, structures; downward Lowenheim Skolem theorem; construction of models from constants, Henkin’s omitting types theorem, prime models; elementary chains of models, basic two cardinal theorems, saturated models, basic results on countable models including Ryll-Nardzewski’s theorem; indiscernible sequences, Ehrenfeucht-Mostowski models; introduction to stability, rank functions, primary models, and a proof of Morley’s categoricity theorem; basic facts about infinitary languages, computation of Han-Morley numbers.

21-604 Introduction to Recursion Theory
Intermittent: 12 units
Models of computation, computable functions, solvable and unsolvable problems, reducibilities among problems, recursive and recursively enumerable sets, the recursion theorem, Post’s problem and the Friedberg-Muchnik theorem, general degrees and r.e. degrees, the arithmetical hierarchy, the hyper-arithmetical hierarchy, the analytical hierarchy, higher type recursion. 3 hrs. lec.

21-610 Algebra I
Spring: 12 units
The structure of finitely generated abelian groups, the Sylow theorems, nilpotent and solvable groups, simplicity of alternating and projective special linear groups, free groups, the Nielsen-Schreier theorem. Vector spaces over division rings, field extensions, the fundamental Galois correspondence, algebraic closure. The Jacobson radical and the structure of semisimple rings. Time permitting, one of the following topics will be included: Wedderburn’s theorem on finite division rings, Frobenius’ theorem. Prerequisite: Familiarity with the content of an undergraduate course on groups and rings. 3 hrs. lec.

21-620 Real Analysis
Fall: 6 units
A review of one-dimensional, undergraduate analysis, including a rigorous treatment of the following topics in the context of real numbers: sequences, compactness, continuity, differentiation, Riemann integration. (Mini-course. Normally combined with 21-621.) 3 hrs. lec.

21-621 Introduction to Lebesgue Integration
Fall: 6 units
Construction of Lebesgue measure and the Lebesgue integral on the real line. Fatou’s Lemma, the monotone convergence theorem, the dominated convergence theorem. (Mini-course. Normally combined with 21-620.) 3 hrs. lec.

21-630 Ordinary Differential Equations
All Semesters: 12 units
Basic concepts covered are existence and uniqueness of solutions, continuation of solutions, continuous dependence, and stability. For autonomous systems, topics included are: orbits, limit sets, Liapunov’s direct method, and Poincaré-Bendixson theory. For linear systems, topics included are: fundamental solutions, variation of constants, stability, matrix exponential solutions, and saddle points. Time permitting, one or more of the following topics will be covered: differential inequalities, boundary-value problems and Sturm-Liouville theory, Floquet theory.

21-640 Introduction to Functional Analysis
Spring: 12 units
Prerequisites: 21-651 and (21-621 or 21-720).

21-651 General Topology
Fall: 12 units

21-660 Introduction to Numerical Analysis I
Spring: 12 units
Finite precision arithmetic, interpolation, spline approximation, numerical integration, numerical solution of linear and nonlinear systems of equations, optimization in finite dimensional spaces. 3 hrs. lec.

21-690 Methods of Optimization
Fall: 12 units
Mechanical Engineering Courses

24-101 Fundamentals of Mechanical Engineering
Fall and Spring: 12 units
The purpose of this course is to introduce the student to the field of mechanical engineering through an exposition of its disciplines, including structural analysis, mechanism design, fluid flows, and thermal systems. By using principles and methods of analysis developed in lectures, students will complete two major projects. These projects will begin with conceptualization, proceed with the analysis of candidate designs, and culminate in the construction and testing of a prototype. The creative process will be encouraged throughout. The course is intended primarily for CE freshmen. 3 hrs. lec., 2 hrs. rec./lab.

24-200 Machine Shop Practice
Fall and Spring: 1 unit
24-200 Machine Shop Practices Fall and Spring Semesters, 1 units, 6 week mini course This course familiarizes students with the operation and safety of machine tools. This gives students knowledge of what goes into engineering designs in building a prototype and also enables them to operate shop machinery as a part of future courses. Prerequisite: Undergraduate Mechanical Engineering standing 2 hours lab Machine Shop Practices should be completed prior to Design II 24-441. However, if necessary, it may be scheduled concurrently with Design II in the first mini of the semester.

24-201 Engineering Graphics
Fall and Spring: 9 units
Introduction to the use and preparation of manually and computer generated engineering drawings, including the following topics: basic drawing techniques; dimensioning of orthographic drawings; auxiliary and oblique views; sectional drawings; working drawings; blueprint reading; freehand sketching; production standards, methods, and symbols; simplified drawing techniques; intersection and development; basic applied descriptive geometry. 3 hrs. res., 3 hrs. lab.

24-202 Introduction to Computer Aided Design
Fall: 1 unit
Introduction to computer aided mechanical design using SolidWorks 3D CAD software. Includes the creation and analysis of components and assemblies, generation of drawings, and exporting for manufacture. Two hours of guided computer lab work each week.

24-221 Thermodynamics I
Fall: 10 units
Temperature and thermometry; equations of state for fluids and solids; work, heat, and the first law; internal energy, enthalpy, and specific heats; energy equations for flow; change of phase; the second law, reversibility, absolute temperature, and entropy; combined first and second laws; availability, power and refrigeration cycles. Applications to a wide range of processes and devices, 3 hrs. lec., 1 hour recitation
Prerequisites: 24-101 and 33-106 and (21-122 or 21-123).

24-231 Fluid Mechanics
Spring: 10 units
Hydrostatics. Control volume concepts of mass, momentum, and energy conservation. Euler’s and Bernoulli’s equations. Viscous flow equations. Head loss in ducts and piping systems. Dimensional analysis and similarity as an engineering tool. Measurement techniques. 3 hrs. lec., 1 hr. rec.
Prerequisites: 33-106 and (21-122 or 21-123).

24-261 Statics
Fall: 10 units
This course is the first in a two-semester sequence on the solid mechanics of engineering structures and machines. The course begins with a review of the statics of rigid bodies, which includes the identification of statically indeterminate problems. Two- and three-dimensional statics problems are treated. Thereafter, the course studies stresses and deflections in deformable components. In turn, the topics covered are: simple tension, compression, and shear; thin-walled pressure vessels; torsion; and bending of beams. For each topic, statically indeterminate problems are analyzed and elementary considerations of strength are introduced. 3 hrs. lec., 1 hr. rec./lab.
Prerequisites: (21-118 or 21-122 or 21-123) and 33-106.
24-262 Stress Analysis
Spring: 12 units
This course is the second in a two-semester sequence on the solid mechanics of engineering structures and machines. The basic topics of uniaxial tension/compression, torsion, and flexural deformation from 24-261 are reviewed. Combined loadings and stresses are then treated, which lead to a consideration of failure criteria. Two-dimensional elasticity and the finite element method are introduced. Stress concentrations are quantified analytically, numerically, and with the use of engineering handbooks. Cyclic failure criteria are introduced, and both static and cyclic failure criteria are applied to results from numerical analysis. 3 hrs. lec., 1 hr. rec./lab.
Prerequisites: 24-261 and 33-106.

24-302 Mechanical Engineering Seminar I
Fall and Spring: 2 units
The purpose of this course is to help students develop good presentation skills and to provide a forum for presentations and discussions of professional ethics. Students will make at least two presentations, one of which is related to professional ethics. Student grades will be based on their presentation skills and their participation in class discussions. 1 hr. rec.
Prerequisites: Junior standing or permission of instructor.

24-311 Numerical Methods
Fall: 12 units
Use of numerical methods for solving engineering problems with the aid of a digital computer. The course will contain numerical methods such as roots of equations, linear algebraic equations, optimization, curve fitting, and integral and differential equation solving. MATLAB will be used as the programming language. Programming cluster laboratory times will be available twice a week. Problems will be drawn from all fields of interest to mechanical engineers. 3 hrs. lecture plus lab
Prerequisite: 21-260.

24-321 Thermal-Fluids Experimentation and Design
Spring: 12 units
24-321 Thermal-Fluids Experimentation and Design Spring: 12 units This is a capstone course for the thermal-fluids core-course sequence. This course is comprised of two elements: experimentation and design. The experimental experience covers techniques of measurement, uncertainty analysis, and realization of systems, which demonstrate fundamental principles in thermodynamics, fluid mechanics, and heat transfer. The practice of designing a thermal system is also integrated into this course. 4 hrs. lec./lab
Prerequisites: 24-221 (Thermodynamics I), 24-231 (Fluid Mechanics), 24-322 (Heat Transfer)

24-322 Heat Transfer
Fall: 10 units
Prerequisites: 21-260 and 24-221 and 24-231.

24-324 Energy and Thermal Systems Analysis
Fall: 9 units
Fall: 9 units Energy and Thermal Systems Analysis Performance studies of various thermal processes and devices with emphasis on energy utilization. The concepts of gas mixtures, chemical potential, and energy (availability) analysis will be introduced and applied. Examples will be drawn from cogeneration and nuclear power plants, jet propulsion, internal combustion engines, desalination, and fuel cells. 3 hrs. rec.
Prerequisites: 24-221, 24-231.

24-331 Viscous Flow
Intermittent: 10 units
The concept of fluid shear and viscosity and viscous flow in tubes and channels. Hydrodynamic lubrication of bearings. The concept of turbulence and turbulent flow in tubes and channels. The boundary layer concept and applications to momentum transfer (heat convection), and mass transfer (evaporation, etc.). 3 hrs. rec.
Prerequisites: 21-259 and 21-260 and 24-221 and 24-231.

24-332 Potential Flow Aerodynamics
Intermittent: 9 units
Development of the fundamental equations of incompressible frictionless flow: Concepts of circulation, vorticity, irrotationality, stream function, and velocity potential. Two-dimensional low speed airfoil theory; lift and moment calculations for the infinite span wing; empirical airfoil data for real airfoils; thin airfoil theory. Three-dimensional effects; flow distribution; Prandtl’s wing theory; induced drag; the elliptic lift distribution; the general lift distribution. 3 hrs. rec.
Prerequisites: 21-259 and 21-260 and 24-231.

24-333 Gas Dynamics
Intermittent: 9 units
Prerequisites: 21-259 and 21-260.

24-341 Manufacturing Sciences
Spring: 9 units
This course has two broad concerns: an introductory review of manufacturing systems organization and a review of common manufacturing processes from the point of view of design for manufacturability. The features of mass and batch production are quantitatively considered. The basic principles of group technology and production planning are outlined. The use of computers in manufacturing is described, together with a review of the current capabilities of industrial robots. Students will be involved in weekly seminars, which will describe the basic features of common manufacturing processes, including metal machining, metal forming, polymer processing, casting techniques, joining techniques, ceramic processing, and powder processing. Case studies from industry and films may be used. 3 hrs. rec.
Prerequisite: 24-262.

24-351 Dynamics
Fall: 10 units
This first course on the modeling and analysis of dynamic systems concentrates on the motion of particles, systems of particles, and rigid bodies under the action of forces and moments. Topics include the kinematics of motion in rectangular, polar, and intrinsic coordinates; relative motion analysis with multiple reference frames; and planar kinetics through the second law, work-energy method, and impulse-momentum method. Time and frequency domain solutions to first and second order equations of motion are discussed. 3 hrs. lec. 1 hr. rec.
Prerequisite: 24-261.

24-352 Dynamic Systems and Controls
Spring: 12 units
This course presents classical (i.e., nonrelativistic) dynamics via the vector formulation of Newtonian mechanics and the analytical dynamics of Lagrange’s equations. Classical dynamics is used for the purpose of obtaining mathematical models of dynamic systems which are then employed in the analysis of dynamic behavior and in design synthesis. Course contents include a review of particle kinematics and Newton’s laws, kinematics of rigid bodies in general motion, Newtonian kinetics of rigid bodies including the Newton-Euler equations of motion, impulse-momentum and work-energy methods, fundamentals of analytical mechanics including the principle of virtual work and Hamilton’s principle leading to Lagrange’s equations of motion, and advanced issues of analytical mechanics. 3 hrs. lec.
24-355 Kinematics and Dynamics of Mechanisms  
Intermittent: 9 units  
This design-oriented course addresses the kinematics and dynamics of mechanisms with applications to linkage systems, reciprocating engines, and industrial machinery. Conventional as well as innovative rigid-body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis. The course bridges analysis and design by emphasizing the synthesis of mechanisms. To stimulate a creative approach, homework and project work draw upon actual engineering design problems. 3 hrs. rec.  
Prerequisite: 24-351.

24-356 Engineering Vibrations  
Intermittent: 11 units  
Frequency response of linear mechanical systems, with and without damping. Use of computational methods for simulating system response and the use of modal analysis for understanding the vibratory response of complex systems. Lumped and distributed mass systems. Applications include isolation, stability, and balancing. 3 hrs. lec., 1 hr. rec.  
Prerequisite: 21-260.

24-361 Intermediate Stress Analysis  
Intermittent: 10 units  
This course first reviews important solutions from strength of materials, Mohr’s circle, and multiaxial failure theories. Students are then introduced to the theory of elasticity with an emphasis on understanding the field equations and boundary conditions. A short introduction to the theory of finite element methods is given. Additional topics covered include buckling, stress concentrations, plasticity, and fracture mechanics. An important aspect of the course is teaching students how topics covered in class can be applied to predict or understand failures in engineering applications. Another important skill that is emphasized is the application of fundamentals from the lectures and physical intuition to interpret results generated by finite element models. 3 hrs. lec., 1 hr. lab.  
Prerequisites: 21-259 and 24-262.

24-365 Special Topics: Applied Finite Element Analysis  
Intermittent: 9 units  
This is an introductory course for the finite element method with emphasis on application of the method to a wide variety of problems. The theory of finite element analysis is presented and students learn various applications of the method through labs using ANSYS. Various types of analyses are considered including static, pseudo-static, dynamic, modal, buckling, contact, heat transfer, thermal stress and thermal shock. The students use truss, beam, spring, solid, plate, and shell elements in the models created. 9 units  
Prerequisite: 24-262.

24-370 Engineering Design I: Methods and Skills  
Spring: 12 units  
24-370 Engineering Design I: Methods and Skills Spring: 12 Units In this course, students will learn methods and skills for the engineering design process, consisting of four stages: concept design, detail design, analysis, and manufacturing. The course covers the engineering design process in a holistic fashion by discussing theories and practices of the four stages and interrelating them. Hands-on assignments, including computational and physical projects, are given to enhance the learning outcome. After taking this course, students will be able to: express ideas in sketches; interpret and create engineering drawings; select and apply machine elements; model detailed shapes with CAD tools; analyze product performance with CAE tools; choose materials and manufacturing schemes, and create and test prototypes. Recommended: 24-200 (machine shop practice). Co-requisites: 24-262 (stress analysis) and junior status.  
Corequisite: 24-262.

24-380 Special Topics in Mechanical Engineering  
Intermittent: 9 units  
The Special Topics in Mechanical Engineering courses provide students with exposure to a variety of advanced concepts related to Mechanical Engineering and are offered on an “as available” basis. The final digit reflects the primary application area of the material, where 0 is professional; 1 is mathematics; 2 is thermal engineering; 3 is fluid mechanics; 4 is design and manufacturing; 5 is dynamics and controls; and 6 is solid mechanics.

24-391 Mechanical Engineering Project  
All Semesters  
Practice in the organization, planning, and execution of appropriate engineering projects. These investigations may be assigned on an individual or a team basis and in most cases will involve experimental work. 9 hrs. lab.
24-425 Combustion and Air Pollution Control
Intermittent: 9 units
Formation and control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermochemical equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants in combustion systems. Combustion modifications and post-combustion technologies for pollutant control. Relationship between technology and regional, national, and global air pollution control strategies. The internal combustion engine and coal-fired utility boiler are used as examples. 3 hours lecture Cross listed as 24-740 and 19440/19-740.

24-441 Engineering Design II: Conceptualization and Realization
Fall and Spring: 12 units
24-441 - Engineering Design II: Conceptualization and Realization Fall and Spring 12 units. This course guides students through the design process in the applied design of a practical mechanical system. Lectures describe the typical design process and its associated activities, emphasizing methods for innovation and tools for design analysis. Professional and ethical responsibilities of designers, interactions with clients and other professionals, regulatory aspects, and public responsibility are discussed. The design project is typically completed in teams and is based on a level of engineering knowledge expected of seniors. Proof of practicality is required in the form of descriptive documentation. Frequently, a working model will also be required. Oral progress reports and a final written and oral report are required. 3 hrs. rec., 3 hrs lab Prerequisites: 24-262 (Stress Analysis) and senior standing. Co-requisite: Design I 24-370 (preferred as a prerequisite)/Machine Shop Practice 24-200 (preferred as a prerequisite) Prerequisite: 24-262 Corequisite: 24-370.

24-451 Feedback Control Systems
Fall: 12 units
Fundamentals of feedback control with emphasis on classical techniques and an introduction to discrete-time (computer controlled) systems. Topics include the following: frequency domain modeling and state space modeling of dynamical systems; feedback control system concepts and components; control system performance specifications such as stability, transient response, and steady state error; analytical and graphical methods for analysis and design - root locus, Bode plot, Nyquist criterion; design and implementation of proportional, proportional-derivative, proportional-integral-derivative, lead, lag, and lead-lag controllers. Extensive use of computer aided analysis and design software. 4 hrs lec. Prerequisites: (15-110 or 15-121) and 24-352.

24-452 Mechanical Systems Experimentation
Fall: 9 units
24-452 Mechanical Systems Experimentation Fall : 9 Units Experimentation in dynamic systems and controls. The course will cover translational and rotational systems. Topics will include mechanical elements, natural frequencies, mode shapes, free and forced response, frequency response and Bode plots, transients, transient response and vibration control such as PID control, and stability for single-degree-of-freedom and multi-degree-freedom systems. The course will introduce and use state-of-the-art experimentation hardware and software. 1 hr. lecture, 2 hrs. lab. Co-requisite: 24-352 (Dynamic Systems and Control) (due to scheduling is typically and ideally a pre-requisite) and senior status. THIS COURSE IS FALL ONLY - DSC IS SPRING ONLY Prerequisite: 24-352.

24-484 Decision Tools for Engineering Design and Entrepreneurship
Intermittent: 12 units
24-484 Decision Tools for Engineering Design and Entrepreneurship 12 Units This course provides engineers with a multidisciplinary mathematical foundation for integrated modeling of engineering design and enterprise planning decisions in an uncertain, competitive market. Topics include economics in product design, manufacturing and operations modeling and accounting, consumer choice modeling, survey design, conjoint analysis, decision-tree analysis, optimization, game theory, model integration, and professional communication skills. Students will apply theory and methods to a team project for a new product or emerging technology of their choice, developing a business plan and technical and economic competitiveness. Students may choose to select emerging technologies from research at Carnegie Mellon for study in the course, and in some years venture capitalists and other industry leaders will take part in critiquing student projects. This course assumes some prior programming experience in Matlab. Prerequisites: Senior standing and 21-259 or instructor approval (Cross listed with 24-784, 19-484 and 19-784) Prerequisite: 21-259.

24-491 Department Research Honors
Fall and Spring
This course is designed to give students increased exposure to “open-ended” problems and research type projects. It involves doing a project on a research or design topic and writing a thesis describing that project. The project would be conducted under the supervision of a mechanical engineering faculty member (the advisor), and must be approved by the advisor before inception. This course can be taken at any time after the junior year and before graduation which includes the summer after the junior year. Completion of 18 units of this course with a grade of B or better is a partial fulfillment of the requirements for Departmental Research Honors.

24-492 Department Research Honors
Fall and Spring
This course is designed to give students increased exposure to “open-ended” problems and research type projects. It involves doing a project on a research or design topic and writing a thesis describing that project. The project would be conducted under the supervision of a mechanical engineering faculty member (the advisor), and must be approved by the advisor before inception. This course can be taken at any time after the junior year and before graduation which includes the summer after the junior year. Completion of 18 units of this course with a grade of B or better is a partial fulfillment of the requirements for Departmental Research Honors.

24-614 Microelectromechanical Systems
Intermittent: 12 units
This course introduces fabrication and design fundamentals for Microelectromechanical Systems (MEMS): on-chip sensor and actuator systems having micron-scale dimensions. Basic principles covered include microstructure fabrication, mechanics of silicon and thin-film materials, electrostatic force, capacitive motion detection, fluidic damping, piezoelectricity, piezoresistivity, and thermal micromechanics. Applications covered include pressure sensors, micromirror displays, accelerometers, and gas microsensors. Grades are based on exams and homework assignments. 4 hrs. lecture Prerequisite for undergraduates: 18-321 or 24-351 Prerequisite for: 18-724/24-724. Cross-listed 18-614. Prerequisites: 18-321 or 24-351.

24-615 Microfluidics
Intermittent: 12 units
This course offers an introduction to the emerging field of microfluidics with an emphasis on chemical and life sciences applications. During this course students will examine the fluid dynamical phenomena underlying key components of “lab on a chip” devices. Students will have the opportunity to learn practical aspects of microfluidic device operation through hands-on laboratory experience, computer simulations of microscale flows, and reviews of recent literature in the field. Throughout the course, students will consider ways of optimizing device performance based on knowledge of the fundamental fluid mechanics. Students will explore selected topics in more detail through a semester project. Major course topics include pressure-driven and electrokinetically-driven flows in microchannels, surface effects, micro-fabrication methods, micro/nanoparticles for biotechnology, biochemical reactions and assays, mixing and separation, two-phase flows, and integration and design of microfluidic chips. Undergraduate Fluid Mechanics prerequisite or instructor permission 4 hrs. lecture.

24-616 Tribology-Friction, Lubrication and Wear
Intermittent: 12 units
24-616 - Tribology – Friction, Lubrication and Wear Intermittent: 12 units Covers the science of surfaces interacting via dry, lubricated, and mixed (i.e., dry + lubricated) contact. Fundamental aspects include the Reynolds Equation, thermal-tribology, friction, and wear. Applied topics include bearings, surface analysis, nanomanufacturing, and biotribology. The course will conclude with a team project which will require computer programming. 4 hrs lec. Prerequisite: None.
24-619 Biological Fluid Mechanics
Spring: 12 units
Fluid dynamics and transport phenomena applied to the biological and biomedical problems are studied through selected topics from cardiovascular fluid dynamics, swimming/flying in nature and biomimetics. Objectives: (1) to equip students with the fluid dynamics tools in order to design and perform contemporary research in physiological and biological and biomedical fluid mechanics. (2) Review and understand emerging biomimetic engineering, emphasizing the quantitative understanding and fundamental engineering concepts. Computational and experimental techniques (CFD, flow visualization, PIV, LDV, POD, confocal microscopy) will be studied with hands on research projects based on student’s interest. Problem solving of interdisciplinary (biology/clinician/engineer) collaboration are emphasized. Applications include time permitting: bio-inspired fluid dynamic systems, cardiovascular fluid dynamics, multi-phase, microcirculation, aquatic locomotion and propulsion in cellular (planktons, bacteria) and larger scale systems (avian, fish, squid, insects), Rocks/school dynamics. Prerequisites: Familiarity with elementary fluid mechanics and introductory Matlab programming.

24-623 Molecular Simulation of Materials
Spring: 12 units
24-623: Molecular Simulation of Materials Spring: 12 units The purpose of this course is to expose engineering students to the theory and implementation of numerical techniques for modeling atomic-level behavior. The main focus is on molecular dynamics and Monte Carlo simulations. Students will write their own simulation computer codes, and learn how to perform calculations in different thermodynamic ensembles. Consideration will be given to heat transfer, mass transfer, fluid mechanics, mechanics, and materials science applications. The course assumes some knowledge of thermodynamics and computer programming. 4 hrs lec. Prerequisite: None.

24-626 Special Topics - Air Quality Engineering
Intermittent: 12 units
Problems and methodologies for studies of environmental management, with an emphasis on air pollution. Key topics include sources of pollutants, focusing on combustion chemistry for a hydrocarbon fuel; behavior of gaseous and particulate pollutants in the atmosphere including the role of meteorology and the use of dispersion equations; effects of pollutants on human health and global climate; and procedures by which air pollution standards are developed and enforced by regulatory agencies. Statistical treatment of data is included at several places in the course. 12 units.

24-642 Fuel Cell Systems
Fall: 12 units
Fuel cells are devices that convert chemical potential energy directly into electrical energy. Existing fuel cell applications range from the small scale, such as portable cell phone chargers, to the large scale, such as MW-scale power plants. Depending on the application, fuel cell systems offer unique advantages and disadvantages compared with competing technologies. For vehicle applications, they offer efficiency and environmental advantages compared with traditional combustion engines. In the first half of the course, the focus is on understanding the thermodynamics and electrochemistry of the various types of fuel cells, such as calculating the open circuit voltage and the sources of voltage loss due to irreversible processes for the main fuel cells types: PEM/SOFC/MFC. The design and operation of several real fuel cells are then compared against this theoretical background. The second half of the course focuses on the balance-of-plant requirements of fuel cell systems, such as heat exchangers, pumps, fuel processors, compressors, as well as focusing on capital cost estimating. Applying the material learned from the first and second halves of the class into a final project, students will complete an energy & economic analysis of a fuel cell system of their choice. Prerequisite- Undergraduate Thermodynamics course 12 units
Prerequisites: 06-221 or 24-221 or 27-215.

24-655 Cellular Biomechanics
Intermittent: 9 units
24-655 - Cellular Biomechanics Intermittent: 9 units This course discusses how mechanical quantities and processes such as force, motion, and deformation influence cell behavior and function, with a focus on the connection between mechanics and biochemistry. Specific topics include: (1) the role of stresses in the cytoskeleton dynamics as related to cell growth, spreading, motility, and adhesion; (2) the generation of force and motion by motor molecules; (3) stretch-activated ion channels; (4) protein and DNA interactions; and (5) mechanosensitive chemical signaling in signal transduction. If time permits, we will also cover protein trafficking and secretion and the effects of mechanical forces on gene expression. Emphasis is placed on the biomechanics issues at the cellular and molecular levels; their clinical and engineering implications are elucidated. 3 hrs lec. Prerequisite: Instructor permission.

24-656 Advanced Manufacturing
Intermittent: 12 units
24-656 Advanced Manufacturing Intermittent: 12 units This course focuses on modeling of material removal processes, including the turning, milling, boring, and drilling processes. The course also includes introduction on economics of material removal, non-traditional material removal processes, stability of machining processes, tool wear and tool life, dimensional and surface metrology, and experimental methods in manufacturing. A term project that may involve experiments is an integral part of the course. 4 hrs lec. Prerequisite: Senior or Graduate Standing.

24-657 Molecular Biomechanics
Intermittent: 9 units
This course is designed to present concepts of molecular biology, cellular biology and biophysics at the molecular level together with applications. Emphasis will be placed both on the biology of the system and on the fundamental physics, chemistry and mechanics which describe the molecular level phenomena within context. In addition to studying the structure, mechanics and energetics of biological systems at the nanoscale, we will also study and conceptually design biomimetic molecules and structures. Fundamentals of DNA, globular and structured proteins, lips and assemblies thereof will be covered. Prerequisites: Thermodynamics (06-221 or 24-221) or permission from the instructor.

24-658 Computational Bio-Modeling and Visualization
Spring: 12 units
Biomedical modeling and visualization play an important role in mathematical modeling and computer simulation of real/artificial life for improved medical diagnosis and treatment. This course integrates mechanical engineering, biomedical engineering, computer science, and mathematics together. Topics to be studied include medical imaging, image processing, geometric modeling, visualization, computational mechanics, and biomedical applications. The techniques introduced are applied to examples of multi-scale biomodeling and simulations at the molecular, cellular, tissue, and organ level scales. 4 hrs. lec./lab.

24-661 Vibrations of Linear and Dynamic Systems
Intermittent: 12 units
The subject area for this course is mechanical vibration, at a level appropriate for first-year graduate students. Classical techniques in mechanical vibration are developed for the modeling and analysis of discrete and continuous linear systems. Continuous systems are described within the broader context of operator theory to emphasize the physical and mathematical analogies with discrete systems. Specific topics include: Discrete systems. Equations of motion for multiple degree of freedom systems through Lagrange’s method; linearization about equilibrium; symmetry and definiteness properties; free vibration; matrix eigenvalue problems; orthogonality; generalized coordinates; transient and forced response through modal analysis. Continuous systems. Classical rod, shaft, string, beam, membrane and plate models; Hamilton’s principle; equations of motion and boundary conditions through variational methods; essentials of functional analysis; exact solution of eigenvalue problems; response through modal analysis and Green’s function methods; global discretization; Galerkin’s method; essential and suppressible boundary conditions; Kamke quotient; introduction to elastic wave propagation. Lecture 4.0 hours.

24-674 Special Topics in Design of Biomechatronic Systems for Humans
Intermittent: 12 units
This course explores methods for the design of electromechanical devices that physically interface with humans to improve biomechanical performance, such as robotic prostheses and exoskeletons. Students will learn how to develop rigid-body dynamical models, perform forward-dynamic simulations, and use these to generate and evaluate potential interventions. Students will learn about state-of-the-art actuation and sensing systems, and design selected types to meet dynamic performance criteria. We will cover technology for interfacing these devices with humans, and implications for the resulting biomechatronic systems. Students will learn experimental methods for evaluating intervention effectiveness, including inverse dynamics and metabolics analyses. In addition to homework and readings, students will complete a final project that involves introduction of novel elements to a biomechatronic system. Students need a foundation in dynamics, machine design, and numerical tools such as Matlab, and will benefit from knowledge of biomechanics. 12 units.
24-675 Micro/Nano Robotics
Spring: 12 units
This course focuses on the design, modeling, fabrication, and control of miniature mobile robot and micro/nano-manipulation systems for graduate and upper level undergraduate students. It provides an overview of the state-of-the-art micro- and nanoscale sensors, actuators, manipulators, energy sources, robot design, and control methods. It requires active student participation, interaction, and in-class discussions. In addition to the basic background, it includes many case studies of current miniature robots and micro/nano-systems, challenges and future trends, and potential applications. The course requires a final project involving novel theoretical and/or experimental ideas for micro/nano-robotic systems with a team of students. Depending on the equipment availability, these projects can also involve hands-on experience and experimental demonstrations. 4 hrs. lecture. Prerequisites: Permission of the instructor.

24-676 Bio-Inspired Robotics
Fall: 12 units
This course will explore design and control of biologically inspired robots. Locomotion principles of many agile animals such as lizards, snakes, insects, fishes, and birds will be studied with corresponding bio-inspired robotic platforms. Required bio-inspired robotic mechanisms, materials, actuators, sensors, and power sources to enable similar locomotion principles will be taught. Besides the basic background knowledge, it will include the current trends in literature, detailed case studies and discussions, and guest lecturer talks. Course projects will involve theoretical and hands-on topics on design, manufacturing and control of bio-inspired robots. 4 hrs. lec.

24-681 Computer-Aided Design
Intermittent: 12 units
This course is the first section of the two-semester sequence on computational engineering. Students will learn how computation and information technologies are rapidly changing the way engineering design is practiced in industry. The course covers the theories and applications of the measurement representation, modeling, and simulation of three-dimensional geometric data used in the engineering designed process. Students taking this course are assumed to have knowledge of the first course in computer programming. 4 hrs. lecture, 2 hrs. computer cluster Prerequisites: None.

24-682 Computer-Aided Engineering
Intermittent: 12 units
This course is the second in the two-semester sequence on computational engineering. Students will learn how computation and information technologies are rapidly changing the way engineering analysis is practiced in industry. The course covers the theories and applications of finite element methods, finite element mesh generation, robot manipulator kinematics, and inverse kinematics, and manufacturing process optimization. Students taking this course are assumed to have knowledge of the first course in computer programming. 4 hrs. lecture, 2 hrs. computer cluster Prerequisites: None.

24-683 Design for Manufacturing and the Environment
Fall: 12 units
Design for Manufacturing and the Environment examines influences of manufacturing and other traditionally downstream issues on the overall design process. Manufacturing is one facet that will be examined. Other downstream influences that will be studied include: assembly, robustness and quality, platform design, maintenance and safety, economics and costing, lean manufacturing and globalization. In addition, a core part of the course will focus on environment-based design issues. The class will study basic fundamentals in each of these areas and how they affect design decisions. Prerequisites: Senior standing in mechanical engineering, or permission of instructor.

24-684 Integrated Product Development
Spring: 12 units
The IPD course focuses on team-based integrated product development among engineering, business, and design disciplines. The semester course consists of four modules including identifying, understanding, conceptualizing and refining a product opportunity, interdisciplinary teams of students engineering, business, and industrial design learn methods to research the needs, wants and desires of a market opportunity, define product specifications, conceptualize products to meet the users’ needs and desires and refine the most promising concept. The result is a resolved form, functional design, and marketing plan. The course also focuses on communication of the project through multiple presentations and reports. Crosslisted as 45-929, 51-414, 51-814, 39-600.

24-687 Special Topics Grand Challenges: Technology Identification and Product Design
Intermittent: 12 units
Grand Challenges: Technology Identification and Product Design. There are many challenges to society that must be solved over the next century. The National Academy of Engineers have laid out 14 “Grand Challenges” for engineering to solve. However, in addition to the technology that must be identified or invented, the technology must be incorporated within a product (physical, system, infrastructure, service) that delivers value to society through its use. This class is a combination of design research and creation. Students will investigate the technological issues of a Grand Challenge in regards to product needs, then design products that meets short term and long term needs and capabilities to help solve the Grand Challenge. 3 hr. lecture.

24-688 Special Topics: Introduction to CAD and CAE Tools
Intermittent: 12 units
This course offers the hands-on training on how to apply modern CAD and CAE software tools to engineering design, analysis and manufacturing. In the first section, students will learn through 5 or 6 hands-on projects how to model complex free-form 3D objects using commercial CAD tools. In the second section, students will learn through 5 or 6 hands-on projects how to simulate complex multi-physics phenomena using commercial CAE tools. Units: 12 Format: 2 hrs. Lec., 2 hrs. computer lab Prerequisite: None Prerequisites: 24-231 and 24-262 and 24-322.

24-751 Introduction to Solid Mechanics I
Fall: 12 units
This is the first course in a two-part professionally oriented course sequence covering a variety of important problems in solid mechanics. Topics covered typically include torsion of non-circular cross sections, the field equations of elasticity and boundary conditions, and a number of classical plane stress/ plane strain solutions in rectangular and polar coordinates. Emphasis is placed on not only elasticity theory and how classical elasticity solutions are derived, but also on their use in constructing and interpreting the results from finite element simulations of applied engineering problems. Where applicable, comparisons are also made between solutions derived via the full theory of elasticity and simplified solutions developed in strength of materials courses. 4 hrs. lec. Corequisite: 24-701.

24-781 Engineering Computation Project
Fall
This project course is the first section of the two-semester sequence of Computational Engineering Projects. The course provides the students with hands-on problem-solving experience by using commercial computational tools and/or developing their own custom software. Each student, individually or along with other students, will work on a project under the guidance of Carnegie Mellon faculty members and/or senior engineers from industry. Students may select a project topic from those presented by advising faculty members and/or industry engineers. Alternatively, a student may propose and work on his/her own project topic if he/she can identify a sponsoring faculty member or industry engineer.

24-784 Special Topics: Multiscale Modeling Of Engineering Materials
Intermittent: 12 units
This course provides engineers with a multidisciplinary mathematical foundation for integrated modeling of engineering design and enterprise planning decisions in an uncertain, competitive market. Topics include economics in product design, manufacturing and operations modeling and accounting, consumer choice modeling, survey design, conjoint analysis, decision-tree analysis, optimization, game theory, model integration, and professional communication skills. Students will apply theory and methods to a team project for a new product or emerging technology of their choice, developing a business plan to defend technical and economic competitiveness. Students may choose to select emerging technologies from research at Carnegie Mellon for study in the course, and in some years venture capitalists and other industry leaders will take part in critiquing student projects. This course assumes fluency with calculus and some prior programming experience. Graduate students will conduct an additional independent research project.

24-793 Supervised Reading
Fall and Spring
This independent study is designed to give students an opportunity to explore pertinent subjects through directed reading. Variable hrs. Prerequisite: permission of the instructor.
24-794 Master of Science Project
Fall and Spring
This course is designed to be a training opportunity in engineering research and associated professional activity. Content includes a series of investigations under the student’s initiative culminating in comprehensive reports, with special emphasis on orderly presentation and effective English composition for Master of Science candidates. Variable hrs. Prerequisite: permission of the instructor.

Military Science-ROTC Courses

30-101 Introduction to Military Leadership
Fall: 5 units
In this course, students will be introduced to the fundamentals of Army leadership, management and basic military skills. The course emphasizes the Army’s “Principles of Leadership” and familiarizes the student with rifle marksmanship, orienteering and map reading, rappelling, basic lifesaving skills and the wear of the Army uniform. In addition, students will enhance their time management, decision-making and physical fitness abilities. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-102 Foundations of Leadership
Fall: 5 units
This course is a continuation of the subjects and skills taught in 30101. In addition to extending the student’s abilities in the areas of leadership, orienteering and map reading, lifesaving and other basic military concepts, the course also introduces the student to the employment of military units. Individual topics covered include the Army’s emerging technological enhancements, the Army organization and structure and the wartime policies and principles. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-201 Leadership Dynamics and Application
Fall: 5 units
In this course, students will delve more deeply into the Army’s leadership and management techniques, including the application of those techniques in faculty-supervised practical exercises. The course also seeks to enhance the student’s abilities in orienteering and map reading, terrain analysis, advanced lifesaving techniques and physical fitness. Students are introduced to the values that define the United States Army as an American institution, and each student continues to enhance his or her physical development under the supervision of the faculty. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-202 Applications in Leadership and Combat Power
Spring: 5 units
This course continues the study of the topics covered in 30201 and focuses upon practical application of the leadership and management techniques learned in the fall semester. The student develops and applies advanced map reading, terrain analysis, problem-solving and decision-making skills in practical exercises. Additionally, the student is introduced to the Army’s formal orders process, used to maneuver and sustain Army forces on the modern battlefield. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-205 Self Development Survey Skills
All Semesters: 3 units
Self Dev Survey Skills.

30-301 Basic Leader Planning and Combat Operations
Fall: 5 units
This course offers an in-depth analysis and focused practical application of leadership and management techniques. The emphasis in the course is on leader development and the goal is to enhance the student’s ability to perform effectively in a stressful decision-making environment. As such, time management, decision-making, advanced military skills, troop-leading procedures and advanced physical training are emphasized. The course requires participation in a demanding physical training program to prepare contracted students for the Army’s R.O.T.C. Leader Development and Assessment Course (LDAC). Each student must participate in field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students. Veterans with two or more years of service may enroll with approval.

30-302 Advanced Leader Planning and Combat Operations
Spring: 5 units
This course builds upon the foundation laid in the fall semester with the objective of fully preparing contracted students for participation in the Army’s challenging R.O.T.C. Leader Development and Assessment Course (LDAC). The course extends and enhances the student’s leadership, management, communication, fitness and basic military skills in preparing the student for commissioning as an officer in the United States Army. Practical exercises are used to reinforce all of the skills that the student has developed over the course of the military science instruction. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students. Veterans with two or more years of service may enroll with approval.

30-401 Progressive Leadership Theory and Applications
Fall: 5 units
This course is the first of two semester courses that serve as a capstone designed to transition the student from cadet to U.S. Army officer. Students are assigned to command and staff positions within the cadet battalion corresponding to those found in United States Army units. Students perform the duties of the staff or command as assigned and interact with the other cadets as part of a functioning command organization. In addition to studying the operations and organizations of the U.S. Army, students are required to plan and execute the required training and activities in leading the underclass cadets. A variety of topics of current interest are covered. Guest speakers are commonly invited to discuss their military experiences or their perspectives on military-related topics. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students.

30-402 Transition to the Profession of Arms
Spring: 5 units
This capstone course completes the transition from cadet to Army officer and concludes with the student’s commissioning into the United States Army. During the semester, students continue to act in accordance with their assigned staff and command responsibilities and they prepare for their duties as a Lieutenant in the Army. This course covers personal and performance counseling, evaluation of subordinate leaders and team-building skills as well as military justice and discipline. Students bring to bear all of the skills and knowledge that they have accrued over the prior semesters in the Department of Military Science. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students.

Modern Languages Courses

82-101 Elementary French I
Fall and Spring: 12 units
This course is for students who have never studied French. Students will develop contextually appropriate interpersonal communication skills in both written and spoken French, develop reading and listening skills through various media (audio CD, video, CD ROM, ML server, Internet), understand fundamental grammar, acquire vocabulary, and gain a basic understanding of French/francophone cultures. The elementary level is also designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Regular homework and participation in class are mandatory (four in-class hours per week). If a student has studied French before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisite: None.

82-102 Elementary French II
Fall and Spring: 12 units
This course is designed for students who have taken first-semester French at Carnegie Mellon or its equivalent. Students will develop contextually appropriate interpersonal communication skills in both written and spoken French, develop reading and listening skills through various media (audio CD, video, CD ROM, ML server, Internet), understand and begin to control fundamental grammar, acquire vocabulary, and gain a basic understanding of French/francophone cultures. The elementary level is also designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Regular homework and participation in class are mandatory (four in-class hours per week). If a student has studied French outside of Carnegie Mellon, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisites: 82-101 or 82-103.
82-103 Elementary French I Online
Fall: 12 units
This course is designed for students who have never studied French and who need a more flexible approach to language learning than that offered in a standard classroom course. The online courseware is video-based with continuous interaction in learning sequences, with additional use of Internet technologies for research, writing, and communication. There is one class per week plus individual weekly meetings with a tutor or the instructor for conversation and practice. Students will develop contextually appropriate interpersonal communication skills in both written and spoken French, develop reading and listening skills, understand fundamental grammar, acquire vocabulary, and gain a basic understanding of French-francophone cultures. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. If a student has studied French before, then s/he must take the placement exam. Instructors for the placement exam are in BH 160. NOTE: There is a materials fee for taking this course, which is paid by credit card on first login to the course website. Prerequisite: None.

82-104 Elementary French II Online
Spring: 12 units
This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. The online courseware is video-based with continuous interaction in learning sequences, with additional use of Internet technologies for research, writing and communication. There is one class per week plus individual weekly meetings with a tutor or the instructor for conversation and practice. Students will develop contextually appropriate interpersonal communication skills in both written and spoken French, develop reading and listening skills, understand and begin to control fundamental grammar, acquire vocabulary, and gain a basic understanding of French-francophone cultures. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. If a student has studied French before, then s/he must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a materials fee for taking this course, which is paid by credit card on first login to the course website. Prerequisites or placement exam. Prerequisites: 82-101 or 82-103.

82-106 Intensive French Language and Culture: Elementary Level
All Semesters
Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for French.

82-110 Self-Study in Less Commonly Taught Languages
Intermittent
Students who pursue study of a less-commonly taught language that is not offered by the Department of Modern Languages may receive appropriate credit for their work if they demonstrate successful completion of their study at an approved institution of higher learning. The course may provide the option for individualized language instruction for students working at their own pace in consultation with an instructor using materials identified by the National Association of Self Instructional Language Programs. Courses must emphasize the development of oral-aural skills and introduce basic reading and writing. Students must be prepared to devote at least 15 hours per week to individual study in addition to the time spent each week in consultation with their instructor. Enrollment in the course is limited. Permission of the Department Head is needed to take this course.

82-111 Elementary Arabic I
Fall: 12 units
An introduction to Arabic for students with no previous background in the language. Listening, speaking, reading, and writing skills are developed in a context that introduces information on culture and life in the Arabic-speaking countries of today. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours of in-class instruction per week. Prerequisite: None.

82-112 Elementary Arabic II
12 units
This course is designed for students who have taken first-semester Arabic at Carnegie Mellon or its equivalent. The emphasis is on all four skills (listening, speaking, reading, and writing) and on cultural information as it is presented in class and through homework assignments. Regular participation in class is mandatory (four in-class hours per week). In addition, students will be required to spend some time in the Modern Language Resource Center (MLRC) using different multimedia tools to complete assignments. Information on how to use these tools will be provided. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. If a student has studied Arabic before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisite or appropriate placement test score. Prerequisite: 82-111.

82-121 Elementary German I
Fall and Spring: 12 units
An introduction to German for students with no previous background in the language. Listening, speaking, reading, and writing skills are developed in a context that introduces information on culture and life in German-speaking countries of today. Includes work with audio-visual and internet materials. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours of in-class instruction per week. If a student has studied German before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160 and online at http://webcape.byuhtrsc.org/?acct=cmu&g=12296;gr. Prerequisite: None.

82-122 Elementary German II
Fall and Spring: 12 units
This course, the sequel to 82-121, is intended for students with one semester of college German (or equivalent). Listening, speaking, reading, and writing skills are developed in a context that introduces information on culture and life in German-speaking countries of today and in recent history. Includes work with audio-visual and internet materials. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours of in-class instruction per week. Prerequisite or approved equivalent. Prerequisites: 82-121 or 82-122.

82-123 Directed Language Study: Elementary German I or II
Fall and Spring: 12 units
This course is a directed, Instructor-supervised version of the courses 82-121 or 82-122. It is recommended for (I) students who are well motivated and have the time, self-discipline, and desire to work independently, and (2) students whose schedule precludes enrollment in the regular elementary course and (3) Students who have had previous German study but are not prepared to take 82-122. This course develops the fundamental language skills as outlined in the description of 82-121 or 82-122. Students complete the same work as in 82-121 or 82-122. Written work is turned in for correction. Tests covering each unit of material will be taken according to a schedule determined by the Instructor. The Instructor will be available during office hours or by appointment for individual consultations and for testing. Students are permitted to take only one semester of 82-123. YOU MUST ATTEND THE FIRST MEETING. IF YOU CANNOT ATTEND, CONTACT THE INSTRUCTOR BEFORE THE MEETING.

82-126 Intensive German Language and Culture: Elementary Level
Intermittent
Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for German.

82-131 Elementary Chinese I
Fall: 12 units
This course is for beginners in Mandarin Chinese. Its goal is to train students in the basic skills of listening, speaking, reading and writing for daily communication in Chinese. Students will learn the phonetic transcriptions of Chinese (Pinyin) for speaking and listening as well as Chinese characters for reading and writing. Basic vocabulary and sentence patterns used in everyday life are taught so that students will be able to carry on simple conversations on everyday life topics. Students will be introduced to cultural issues through class, extracurricular activities and multimedia programs. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: None.
82-132 Elementary Chinese II
Spring: 12 units
This course is the continuation of the elementary Chinese course sequence for beginning students of Mandarin Chinese. Its goal is to continue to train students in the basic skills of listening, speaking, reading, and writing for everyday communication. Based on the vocabulary and sentence structures taught in the first semester, students will learn more useful expressions and sentence structures necessary for use in everyday life. A large part of the class time will be devoted to conversations related to topics in daily life. While emphasis is laid on the communicative skills of listening and speaking, students will continue to learn to read and write short paragraphs and essays in Chinese characters. To facilitate the study of the language, different aspects of Chinese culture and society will be introduced through poetry reading, group activities, multi-media programs, and research project throughout the course. The elementary level is designed to help students learn to reflect and draw upon strategies used by good language learners in their second language study. Prerequisite: 82-131.

82-133 Elementary Chinese Online I
Fall and Summer: 12 units
This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. It is a Chinese language course designed to help beginners develop communicative competence in the four basic skills of listening, speaking, reading and writing the Chinese language. Basic vocabulary and sentence structures for use in essential daily-life situations, as well as cultural information, are taught through the materials and assignments. Materials are web-based, with extensive use of Internet technologies for research, writing and communication. There is a required weekly class meeting for training and group activities, and individual meetings with a tutor or the instructor for conversation and practice. Elementary Chinese I Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their classwork. If a student has studied Chinese before, then s/he must take a placement exam. Instructions for the placement exam are available in BH 160. Prerequisite: None.

82-134 Elementary Chinese Online II
Spring and Summer: 12 units
This course is the continuation of 82-133, Elementary Chinese I Online. Students will continue learning more useful and complex expressions and sentence structures necessary for use in everyday life. Students will also continue building their skills in listening, speaking, reading, and writing for everyday communication, and their understanding of Chinese culture and society. There is a required weekly class meeting for training and group activities, and individual meetings with a tutor or the instructor for conversation and practice. Elementary Chinese II Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their classwork. Prerequisites or permission of the Instructor. Prerequisites: 82-131 or 82-133.

82-135 Intensive Elementary Chinese
Intermittent: 12 units
This course is designed for students who have some basic knowledge of spoken Chinese, but know little of how to read and write Chinese. While students will be trained in all the four language skills of listening, speaking, reading and writing simultaneously, the focus will be on the study and practice of Chinese characters. Based on their speaking ability, students will learn how to communicate in writing in everyday situations. In addition, the acquisition of standard pronunciation and Chinese cultural awareness will also be stressed. After the study of this course students will be well equipped to continue their study of Chinese at the intermediate level. Prerequisite: None.

82-141 Elementary Spanish I
Fall and Spring: 12 units
A two-semester course sequence (82-141, 82-142) for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language learning resource center work. It also involves studying cultural aspects of Spanish-speaking countries. Prerequisite: None. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160.

82-142 Elementary Spanish II
Fall and Spring: 12 units
The second part of a two-semester course sequence (82-141, 82-142). Prerequisite: 82-141, a placement score or permission of the Instructor. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisites: 82-141 or 82-143.

82-143 Elementary Spanish I Online
Fall: 12 units
This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and b-boards). There is a required, weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: No previous study required. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a required $50 materials fee for taking this course. This fee has to be paid by the end of the official add/drop period to avoid removal from the class.

82-144 Elementary Spanish II Online
Spring: 12 units
A continuation of 82-143 Elementary Spanish I Online. This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and b-boards). There is a required, weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: 82-141, 82-143 or permission of the Instructor. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a required $50 materials fee for taking this course. This fee has to be paid by the end of the official add/drop period to avoid removal from the class. Prerequisites: 82-141 or 82-143.

82-146 Intensive Spanish Language and Culture: Elementary Level
All Semesters
Transfer credit for pre-approved, 100-level study in a Spanish-speaking country or at another approved program at the Elementary level. Credit designed after consultation with the transfer credit advisor for Spanish. Prerequisite: Prior permission of the Hispanic Studies major or minor advisor and confirmation of credit upon return.

82-147 Accelerated Elementary Spanish
Intermittent: 12 units
This course is specially designed for students who are not true beginners of Spanish, and would not be appropriately placed in 82-141, but may also lack adequate preparation to enter the second semester of first-year Spanish. It can also serve students who have not completed the equivalent of the second-semester of Spanish, and would not be appropriately placed in 82-241, the Intermediate Spanish I course. Students in 82-147 will engage in a rapid review of first-semester Elementary Spanish materials and then progress to complete the entire elementary level of Spanish (the second semester) in one semester. Upon successful completion, students will be prepared to continue at the intermediate level. The course emphasizes the development of communicative proficiency though oral practice, aural comprehension, reading, writing, and study of cultural aspects of Spanish-speaking countries. Prerequisite: Permission of the Instructor and an appropriate placement exam score.

82-161 Elementary Italian I
Fall: 12 units
A two-semester course sequence (82-161, 82-162) for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and work with audio tapes and DVDs. Also a study of cultural aspects of Italy. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Note: This is a 12 unit course. Prerequisite: None.
82-162 Elementary Italian II
Spring: 12 units
A two-semester course sequence (82-161, 82-162). The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: 82-161, 82-163 or approved equivalent. Note: This is a 12 unit course. A 9 unit version of this course that does not fulfill DCR3 credits may be offered during a semester for Music students only. Prerequisites: 82-161 or 82-163.

82-163 Directed Language Study: Elementary Italian I or II
Fall and Spring: 12 units
A self-paced version of 82-161/162, for highly-motivated students, capable of working independently. Weekly practice session, language laboratory work with audio and video tapes, periodic achievement tests, and individual consultation. Students are permitted to take only one semester of 82-163. Prerequisite: None.

82-171 Elementary Japanese I
Fall: 12 units
This course is the first part of a two-semester course sequence (82-171, 82-172) for students with no background in Japanese. It emphasizes the development of communicative language proficiency through oral practice, aural comprehension, reading, writing, and the study of cultural aspects of Japanese society. Furthermore, the elementary-level language course is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours in-class instruction per week, plus mandatory homework. Prerequisite: None.

82-172 Elementary Japanese II
Spring: 12 units
This course is a sequel to Elementary Japanese I (82-171) and continues to further the development of communicative language proficiency through oral practice, aural comprehension, reading, writing, and the study of cultural aspects of Japanese society. Furthermore, the elementary-level language course is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours in-class instruction per week, plus mandatory homework assignments. Prerequisite or approved equivalent. Prerequisite: 82-171.

82-176 Intensive Japanese Language and Culture: Elementary Level
Intermittent
Transfer credit for study abroad in Japan or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-180 Freshman Seminar
Intermittent: 9 units
Picasso and Matisse: Artistic Friends or Foes? Henri Matisse and Pablo Picasso were arguably the greatest of the 20th century Europeans artists. Opinions are divided as to which was the greatest. They first met in Paris in 1906 and continued their contact - sometimes personal, sometimes via friends, dealers and collectors, sometimes by “spying” on each other’s work from that moment until Matisse’s death in 1954. Much has been written about their relationship, their influence on each other and whether or not they were really friends or foes. This course will examine closely the work of each of these two masters within the context of 20th century European art. It will look at them individually and comparatively, studying their paintings, sculpture, work in clay and glass as well as their personal relationship. Readings will include personal testimony from those who knew them well, traditional art history texts, several catalogues from major exhibits that compared their work and several videos from these exhibits. Students will be expected to become familiar with the major contributions each of these artists made to 20th century art as well as to the cultural milieu in which they lived and worked. Prerequisite: Freshman Status.

82-181 Freshman Seminar: Introduction to Russian Culture and Civilization
Intermittent: 9 units
This course is intended to fulfill the Freshman Seminar requirement of the General Education Program. This course will deal with the significant cultural achievements of the Russian people in different fields of culture. The main focus will be on the analysis of relationships between Russian and Western cultural traditions. The topics chosen for discussion are very important for Russian cultural history and will help in understanding and appreciating some specific ways and achievements in the development of Russian popular culture. Distinctive cultural achievements of Russian high culture will also be highlighted, especially through art and music. In addition to reading assignments, papers and class discussions in the history of Russian culture and civilization, students will be taken to the performances of the Pittsburgh Symphony and Pittsburgh Opera. Attendance at all cultural events is required. Prerequisite: Freshman status.

82-182 Freshman Seminar: Language and Culture: Language in its Social Context
Intermittent: 9 units
This course will explore the relationship between language and culture as it manifests itself in language use in a wide variety of speech communities throughout the world. The purpose of the course will be to demonstrate the multifaceted and complex relationship between language and culture and how language use both exemplifies cultural values and simultaneously serves to reinforce them. The course will consider a wide variety of topics, all of which demonstrate implicit cultural differences and attitudes as manifested through language use. Illustrative examples include analysis of the relationship between language and thought (the Sapir-Whorf linguistic relativity hypothesis); standard versus vernacular languages; attitudes toward language acquisition as it differs from one speech community to another; bilingualism and multiculturalism in this country and throughout the world; diglossia; language, literacy and education; non-verbal aspects of language use; gender-based differences in language and culture; sociolinguistic variables in the ethnography of speaking; language loss and language maintenance; politics, language planning and language policy and the impact of languages in contact. Prerequisite: Freshman status.

82-183 Freshman Seminar: Constructions of Memory and Modernity
Intermittent: 9 units
This course will focus on the arts in society during the period of intense modernization that begins in the middle of the nineteenth century (the Second Empire in France), with an emphasis on the late nineteenth century and the early years of the twentieth century (approximately until the time of World War I [1914-1918]). We will read a wide range of literary, historical, and cultural works in an interdisciplinary, comparative perspective. Our focus is on the cultures of Western Europe and the U.S., with an emphasis on French, Anglo-Irish and English, and German works; the readings will be complemented by study of the visual arts, especially Impressionism and photography, theater, and opera. We will view some of the latter works on film and video, when available. Prerequisite: Freshman status.

82-184 Freshman Seminar: The Birth and Death of Tragedy
Intermittent: 9 units
This is a freshman seminar, taught in English, and it addresses one of the most important questions in the development of Western culture: what is tragedy, how did it evolve, and what does it mean today? Starting with Aischelus’ Oresteia and Aristotle’s Poetics, the seminar explores the nature of tragedy in ancient Greece as a theatrical experience, a literary form, and an expression of Greek culture. Friedrich Nietzsche’s essay The Birth of Tragedy offers an interpretation of the meaning of tragedy in its original context and a link to the nature of tragedy in the modern world. Richard Wagner’s music drama Tristan und Isolde and his theoretical essays, including “Art and Revolution” and “The Art-Work of the Future,” further illustrate and develop the theme, showing how a dominant representative of nineteenth century culture sought to reevaluate and reclaim the tragic form, linking it with an extensive critique of modern culture. Thomas Mann’s Death in Venice provides an early twentieth century variation on the theme of tragedy, and Sigmund Freud’s Civilization and its Discontents, like Nietzsche’s essay, provides a framework for placing tragedy in its cultural context. Finally, Arthur Miller’s Death of a Salesman provides a modern American version of the problem of tragedy. Students in this seminar are asked to write short papers every two to three weeks, and the in-class focus is on intensive discussion and analysis of the texts. Prerequisite: Freshman status.

82-186 Freshman Seminar: Introduction to Russian Culture
Intermittent: 9 units
Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. This course will deal with important cultural achievements of the Russian people in different areas. The main focus will be on the analysis of relationships between Russian and Western cultural traditions. The topics chosen for analysis are significant for Russian cultural history. Class discussions will help students in understanding and appreciating some specific ways and achievements in the development of Russian popular culture. Distinctive aspects of Russian high culture will also be highlighted, especially through art and music. The course will include secondary readings, primary documents, and films. Prerequisite: Freshman status.
82-191 Elementary Russian I
Fall: 12 units
This course begins the Russian language sequence and is offered in the fall semester only. The course takes a communicative approach to teaching basic skills in listening, speaking, reading and writing. Language is presented in communicative contexts illustrating cultural aspects of daily Russian life. Special emphasis is given to developing oral competency. Attendance is required at four hourly class meetings per week. Sometimes a fifth hour per week is spent on consultation and conversation practice with a course assistant. One to two hours per day must be devoted to study and homework assignments. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: None.

82-192 Elementary Russian II
Spring: 12 units
The second part of a two-semester course sequence (82-191, 82-192). Prerequisite or approved equivalent. Prerequisite: 82-191.

82-198 Research Training: Modern Language
Fall and Spring
SPRING 2012 82-198 A9 units, Felipe Gómez Contact by email: fgomez@andrew.cmu.edu, and include information about your interest in this project and linguistic competence. Hispanic Comics This project involves research related to the popular genre of comics in the Hispanic world. The course will teach research, critical reading, and thinking skills useful to students of all majors. Student researchers will assist in: a) identifying, locating and reviewing major examples of comics from the Hispanic world; b) identifying and selecting canonical and recent theoretical and critical readings about the comic genre in the Hispanic world to contribute to a literature review; c) analyzing and categorizing comics according to given criteria. Some of the texts are originally written in English or are available in translation, but most are in Spanish. Possible long-term results of this project include a course of study built around this research, and perhaps a published work (for which student participants would be acknowledged as contributors). Open to one or two students with at least advanced intermediate level reading and reading skills in Spanish. Prerequisite: Permission of the instructor.

82-200 Alternative Break Project (General)
This course provides advanced ML language students and non-ML students enrolled in an Alternative Break student trip project the opportunity to earn credit by engaging in “connected” modes of knowing, by identifying and analyzing a problem, and developing plans for short-term and sustainable solutions, reflecting, and creating and disseminating an informational and interpretive website and print materials about their experience. Students will also bring to bear or gain experience in non-academic skills/talents and interests in areas like photography, image editing, video production, writing, design, website development, sound recording, and art, etc., by doing community service under the auspices of Carnegie Mellon University’s Alternative Break Program. Students will earn three (3) units for full participation and fulfillment of course requirements. With the approval of the faculty facilitator, an additional three (3) units may be earned by completing an additional assignment.

82-201 Intermediate French I
Fall and Spring: 9 units
An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. This course is designed to strengthen listening, speaking, reading and writing, within the context of evolving French and Francophone cultures. Varying with each semester, the course will use classic French and Francophone texts as well as songs, excerpts from newspapers, magazines or films. Prerequisites or appropriate placement test score.
Prerequisites: 82-102 or 82-104.

82-202 Intermediate French II
Fall and Spring: 9 units
An integrated approach to the study of the French culture and language by means of literary and cultural texts and analysis, coupled with a review of the vocabulary, grammar and cultural aspects of French. Intensive practical work in written and spoken French also constitutes the basis for this course as a preparation for the advanced level. Students are invited to explore the French and Francophone worlds as they intersect and sometimes clash, with the goal of fostering better cross-cultural awareness. Possible long-term results of this project include a course of study built around this research, and perhaps a published work (for which student participants would be acknowledged as contributors). Open to one or two students with at least advanced intermediate level reading and reading skills in Spanish. Prerequisite: 82-192 or 82-191.

82-203 Intermediate French I Online
Fall: 9 units
An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. This course is designed to strengthen listening, speaking, reading and writing, within the context of evolving French and Francophone cultures. Varying with each semester, the course will use classic French and Francophone texts as well as songs, excerpts from newspapers, magazines or films. Prerequisites or appropriate placement test score.

82-204 Intermediate French II Online
Spring: 9 units
An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. A continuation of 82-203, Intermediate French I Online, with an emphasis on francophone cultures outside of France. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Students new to French study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class.
Prerequisites: 82-102 or 82-104.

82-206 Intensive French Language and Culture: Intermediate Level
Intermittent
Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for French.

82-211 Intermediate Arabic I
Fall: 9 units
An integrated approach to the study of the Arabic language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Arabic. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Arabic. This course is designed to strengthen listening, speaking, reading and writing, within the context of an evolving Arabic culture. Prerequisite or appropriate placement score.
Prerequisite: 82-112.

82-212 Intermediate Arabic II
Intermittent: 9 units
An integrated approach to the study of the Arabic language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Arabic. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Arabic. This course is designed to strengthen listening, speaking, reading and writing, within the context of an evolving Arabic culture. Prerequisite, placement score, or permission of the instructor.
Prerequisite: 82-112.
82-215 Introduction Modern Arabic Literature and Culture
Spring
This course is designed to acquaint students with the literature and culture of the Arab world. Through lectures, discussions, and class presentations, students will gain knowledge of Arabic fiction and poetry, and examine how these literary productions reflect the cultures, mentalities, and traditions of the Arabs. Students will learn about the religion, social structure, government, and the position of women in the Arab world through presentations of these topics in modern Arabic literature. The course will focus on literature since the beginning of the twentieth century, when the first Arabic novel was published, and also will include a brief survey of older narrative traditions, and how these contributed to modern works. Course grade will be based on a variable assessment method. Students will select from diverse options for writing, presenting, and creative production. With permission of the instructor, it may be possible to earn 3 additional units of credit for work done in Modern Standard Arabic.

82-221 Intermediate German I
Fall and Spring: 9 units
The goal of Intermediate German I is to further develop your linguistic and cultural knowledge, allowing you to feel more comfortable as a user of German. By the end of the semester, you should be able to: use and understand German in everyday situations; communicate effectively in general areas and in individual areas of interest; understand general cultural perspectives in contemporary Germany; read and understand authentic materials from German-speaking countries. Activities will help develop the four skills and of cultural knowledge. Assessment of progress will occur across skills throughout the semester. This course focuses on intercultural concepts and will help you see what things Germans view differently from other nations and what things might be similar. Topics will include issues such as travel, politics, immigration, and music. Taught in German. Prerequisite or approved equivalent. Prerequisites: 82-122 or 82-123.

82-222 Intermediate German II
Fall and Spring: 9 units
In this class, you will expand and develop your speaking, listening, reading, and writing skills, as well as your cultural knowledge of German-speaking countries. Topics include: Life and Love, Art and Artists, and Dealing with History in German-speaking countries. This course focuses on intercultural concepts and will help you see what things Germans view differently from other nations and what things might be similar. Topics will include issues such as views on German history, prospects for Germany’s future, art and artists, and the German film industry. By the end of the course, you should be able to make yourself understood in German and understand German speakers with experience dealing with foreigners. Taught in German. Prerequisite or approved equivalent. Prerequisite: 82-221.

82-226 Intensive German Language and Culture: Intermediate Level
Intermittent
Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for German.

82-231 Intermediate Chinese I
Fall: 12 units
This course is the second semester of Intermediate Chinese, a continuation of the Elementary Chinese course for beginning Chinese students. It aims at helping students expand their vocabulary and knowledge of grammar of the Chinese language by learning new words, expressions and sentence patterns needed for everyday communication and by consolidating their knowledge through oral and written practice in and out of class. In this course, students will participate in classroom discussions in Mandarin Chinese on various topics concerning everyday life and study and learn to write short paragraphs on those topics in Chinese characters. Different aspects of Chinese culture will also be introduced throughout the course through audio and video tapes, lectures and discussions. Prerequisite or permission of the instructor. Prerequisites: 82-231.

82-232 Intermediate Chinese II
Spring: 12 units
This is the second semester of Intermediate Chinese, a continuation of the Elementary Chinese course for beginning Chinese students. It aims at helping students expand their vocabulary and knowledge of grammar of the Chinese language by learning new words, expressions and sentence patterns needed for everyday communication and by consolidating their knowledge through oral and written practice in and out of class. In this course, students will participate in classroom discussions in Mandarin Chinese on various topics concerning everyday life and study and learn to write short paragraphs on those topics in Chinese characters. Different aspects of Chinese culture will also be introduced throughout the course through audio and video tapes, lectures and discussions. Prerequisite or permission of the instructor. Prerequisites: 82-231.

82-235 Intensive Intermediate Chinese
Intermittent: 12 units
This course is the continuation of Intensive Elementary Chinese (82-135). Students will continue to learn the basic skills of listening, speaking, reading and writing for daily communication, while more focus on reading and writing Chinese characters. More variety of expressions and complicated sentence structures will be taught so that students can carry on daily conversations on various topics related to modern Chinese Society. Activities related to the broad spectrum of the Chinese culture will be organized to facilitate the language learning. This course can be a substitute for 82-232 for Chinese Minor. Instructor’s approval is required to register for this course.

82-236 Intensive Chinese Language and Culture: Intermediate Level
Spring
Transfer credit for study abroad in China, a Chinese-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Chinese.

82-241 Intermediate Spanish I
Fall and Spring: 9 units
An integrated approach to the study of Spanish language and Hispanic cultures by means of grammar review, analysis of literary and cultural readings, and films, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. The first part of a two-semester course sequence (82-241, 82-242). Prerequisite or approved equivalent. Prerequisites: 82-142 or 82-144.

82-242 Intermediate Spanish II
Fall and Spring: 9 units
An integrated approach to the study of the Spanish language and Hispanic cultures by means of grammar review, analysis of literary and cultural readings, and films, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. The second part of a two-semester course sequence (82-241, 82-242). Prerequisite or approved equivalent. Prerequisites: 82-241 or 82-243.

82-243 Intermediate Spanish I Online
Intermittent: 9 units
An integrated approach to the study of the Spanish language and Hispanic cultures by means of grammar review, analysis of literary and cultural readings, and films, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. This course is a parallel offering designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and bulletin boards). There is a required weekly class meeting for training and group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a “required” $50 materials fee for taking this course. This fee has to be paid by the end of the official add/drop period to avoid removal from the class. Prerequisite or permission of the instructor. Prerequisites: 82-142 or 82-144 or 82-147.
82-244 Intermediate Spanish II Online
Intermittent: 9 units
An integrated approach to the study of the Spanish language and Hispanic cultures by means of grammar review, analysis of literary and cultural readings, and films, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and language in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. A continuation of 82-243 Intermediate Spanish I Online. This course is a parallel offering designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and e-mail). There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* $50 materials fee for taking this course. This fee has to be paid by the end of the official add/drop period to avoid removal from the class. Completion of both prerequisites or permission of the instructor. Prerequisites: 82-241 and 82-243.

82-246 Intensive Spanish Language and Culture: Intermediate Level
Intermittent
Transfer credit for pre-approved, 200-level study in a Spanish-speaking country or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Spanish. Prerequisite or an approved equivalent, or prior permission of the Hispanic Studies major or minor advisor, and confirmation of credit upon return. Prerequisite: 82-412.

82-261 Intermediate Italian I
Fall: 9 units
An integrated approach to the study of the Italian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Italian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Italian. A two-semester course sequence (82-261, 82-262) for intermediate-level students. Prerequisite or approved equivalent. Prerequisites: 82-162 or 82-163.

82-262 Intermediate Italian II
Spring: 9 units
An integrated approach to the study of the Italian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Italian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Italian. Prerequisite or approved equivalent. Prerequisite: 82-261.

82-271 Intermediate Japanese I
Fall: 12 units
This course is the first part of a two-semester course sequence (82-271, 82-272). It takes an integrated approach to the study of Japanese language and culture, consisting of grammar review, reading, and intensive practice in written and spoken Japanese. Course materials include authentic audiovisual and written texts on top of the assigned textbooks. Also integrated are cultural explorations through direct interactions with native speakers. Four hours of in-class instruction per week, plus mandatory homework assignments. Prerequisites or approved equivalent. Prerequisite: 82-271.

82-273 Introduction to Japanese Language and Culture
Intermittent: 9 units
This course is an introduction to modern Japanese. Given the close link between the Japanese language and culture, the examination of the distinctive characteristics of the Japanese language and its sociocultural context provides important insights into contemporary Japan. The course is taught in English. It is intended both for individuals who want to gain a better understanding of modern Japanese society, as well as for students of the Japanese language. Prerequisites: 82-171 or 82-172 or 82-271 or 82-272 or 82-371 or 82-372.

82-276 Intermediate Japanese Language and Culture: Intermediate Level
Intermittent
Transfer credit for study abroad in Japan or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-278 Japanese Literature in Translation
Fall: 9 units
The primary goal of this course is to provide the student with a broad knowledge of post-war Japanese Literature with some knowledge of pre-war writers. Students learn not only a body of literature but about the use of fiction to explore Japanese culture in the post-war era. The course will examine the works of post-war Japanese writers with the main focus on issues such as the emergence of the “modern” Japanese novel and its influences; dilemmas of a post-war generation of writers dealing with its experience related to the war; and last, but not least, the relevance of literature in providing insight into a culture. Students will also read essays in Japanese history and literary theory that will provide the tools for interpreting the literature in its own cultural and historical context. Prerequisite: 82-171.

82-280 Learning About Language Learning
Fall: 9 units
This seminar focuses on the role of diverse affective, cognitive and social factors in second language learning. All participating students are required to be studying an additional language while taking this seminar. Each class is devoted to discussion of assigned readings as well as to completion of various measures, inventories or questionnaires that assess diverse predictors of second language learning. These data are collected throughout the term, and then analyzed and related to predictions based upon previous research that have been discussed in class. Each student also identifies a “good” or a “poor” second language learner to interview and then report back to the class on the learners’ characteristics. Co-requisite: Study of a foreign language.

82-281 Tutoring for Community Outreach
Intermittent
6-9 units Students participate in a community outreach program and work in the Pittsburgh Public Schools with either elementary school, middle school, or high school students, and, depending on the site, foster their studies of Chinese, French, German, Japanese, Spanish or ESL. The elementary school experience will involve regular visits, mentoring, and tutoring at school sites in the East End of Pittsburgh. The middle school experience provides opportunity for tutoring in Japanese, French, or Spanish at Frick International Studies Academy. The high school experience invites advanced students, majors, or minors in Chinese, French, German, Japanese, or Spanish to work with language students and teachers at local high schools. During the early weeks of the semester, students will meet to arrange their outreach activities and prepare for their experience. Depending on the number of units to be earned, students will spend a certain number of hours per week engaged in some of the following activities: attending and participating in the individual and group meetings, tutoring four to six hours per week, reading and preparing for the school visits, keeping a journal of tutoring experiences, writing a paper or completing a project at the end of the term that reflects experiences. Students earn 6 units by spending 4 hours per week at a school site plus completing related activities. Students earn 9 units by spending 6 hours per week at a school site plus completing related activities. Prerequisites: Permission of the faculty liaison plus completion of an information sheet and clearance forms available in the Department of Modern Languages.
82-282 Community Service Learning  
Intermittent  
82-282 Community Service Learning Carnegie Mellon University in Qatar - Spring 2010 Instructor: Silvia Pessoa: spessoa@qatar.cmu.edu Units: 9 units Course Description: In this course students will work in the community to promote learning of cultures and languages. For Spring 2010 in Qatar, participants in this course will work with the Reach Out to Asia’s Adult English Literacy (RAEL) program for migrant workers. In this course, students will attend class twice a week and spend three hours weekly teaching English in the literacy program. During the early weeks of the semester, students will read about and discuss best practices in adult education, and will familiarize themselves with the program’s objectives and outcomes and the migrant worker student population. The rest of the semester will be spent on preparing for each week’s teaching, teaching an adult literacy evening class, and reflecting upon the experience. Grade will be based on the student’s participation in the program and the completion of a weekly journal and a final paper or project about their experience. Prerequisite: Permission of the instructor.

82-291 Intermediate Russian  
Fall: 9 units  
This course further develops communicative proficiency through intensive practice in written and spoken Russian. Complex grammatical structures and stylistic variations are mastered and extensive vocabulary is acquired. Through reading materials, fictional and non-fictional, acquaintance is made with the basic components of Russian cultural literacy as well as the distinctive cultural aspects of daily Russian life. Attention is directed toward the dynamic interaction of language and culture in order to foster cross-cultural awareness. Attendance is required at three-hourly class meetings per week, but sometimes a fourth hour is spent on consultation with a course assistant. One to two hours per day outside of these meetings must be devoted to study and homework assignments. Prerequisite or approved equivalent. Prerequisite: 82-192.

82-292 Intermediate Russian II  
Spring: 9 units  
This course seeks an integrated approach to the study of the Russian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Russian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Russian. Attendance is required at three-hourly class meetings per week, but sometimes a fourth hour is spent on consultation with a course assistant. One to two hours per day outside of these meetings must be devoted to study and homework assignments. The second part of a two-semester course sequence (82-291, 82-292). Prerequisite or approved equivalent. Prerequisite: 82-291.

82-293 Introduction to Russian Culture  
Intermittent: 9 units  
Russia is one of the oldest European countries and long ago achieved world recognition for its outstanding contributions to Western traditions in art, architecture, music and ballet. This introductory course, based on primary documents, secondary readings, film and music, supplies an understanding of the distinctive cultural spirit of this great nation. Prerequisite: None.

82-294 Topics in Russian Language and Culture  
Intermittent  
This course is taught by visiting faculty members from the Russian State University for the Humanities, and the topic is announced on the occasion of their visit.

82-296 A Century of Russian Film  
Intermittent: 9 units  
This course surveys the dominant works, directors and genres that have defined Russian filmmaking from its birth to the present day. Films are screened during required evening class meetings. Films and assigned readings in film history, theory and criticism are discussed during additional required class meetings.

82-299 Alternative Break Project (General)  
Fall and Spring  
This course provides advanced ML language students and non-ML students enrolled in an Alternative Break student trip opportunity to earn credit by engaging in “connected” modes of knowing, by identifying and analyzing a problem, and developing plans for short-term and sustainable solutions, reflecting, and creating and disseminating an informational and interpretive website and print materials about their experience. Students will also bring to bear or gain experience in non-academic skills/talents/interests in areas like photography, image editing, video production, writing, design, website development, sound recording, and art, etc., by doing community service under the auspices of Carnegie Mellon University’s Alternative Break program. Students will earn three (3) units for full participation and fulfillment of course requirements. With the approval of the faculty facilitator, an additional three (3) units may be earned by completing an additional assignment.

82-301 French for Reading Knowledge  
Intermittent: 9 units  
This course offers an introduction to the written French language for undergraduate students in the humanities. Students will be introduced to the structure of the French language in order to prepare them for their own research needs that will require consultation of sources in French. The course is not intended to develop writing, listening and speaking skills, nor is it intended to prepare students for further study in the regular undergraduate French program. It is intended to help them meet specific needs in their research in areas such as history, art and music history, literature, and literary and cultural studies. Prerequisite: Permission of the instructor.

82-303 French Culture  
Fall and Spring: 9 units  
The purpose of this class is to advance grammatical, communicative and cultural proficiency, through an in-depth study of France and the French. Attempts will be made at defining the French “identity”, or what it means to be French, through the study of aspects of French history, French institutions, regions, literature, etc. Examples may be drawn from television and films, songs, and complete literary works, spanning the ages. Great emphasis will be placed on the expression of critical judgment in both oral and written form, documented through readings and personal research. Prerequisites: 82-202 or 82-204.

82-304 The Francophone World  
Fall and Spring: 9 units  
This course introduces the students of French to several of the francophone regional cultures outside of France, including North and West Africa, Belgium, Switzerland, Quebec and North America, and the Antilles. The culture is commonly associated with the French language but is primarily based on Christian and Cartesian European tradition. Through the experience of this course, you will learn of the multiple synthetic cultural realities which have arisen through the colonial and post-colonial processes of contact between European and non-European cultures, and which are now expressed through the medium of the French language. Materials studied will include novels, short stories, essays, newspaper and scholarly articles, film, documentary video and song. The course also introduces students to the formal requirements of contemporary cultural study, thus assignments will include analyses that demonstrate the ability to express critical judgments in both written and oral form, using accepted academic conventions for research documentation and exposition. Prerequisite or permission of the instructor. Prerequisite: 82-303.

82-305 French in its Social Contexts  
Fall: 4 units  
This course will focus on culture through language variation in spoken and written forms of French. Readings, videos, web use, and in-class conversations will involve phonological and sociolinguistic aspects of the French language and language change, its use regarding different registers and regional languages within France, the question of social identity through language, immigration and generational issues, and an exploration of the distinctive francophone uses of the French language. In addition, students will be prepared to discuss current issues in France and francophone regions/countries by using multimedia tools available in the Modern Language Resource Center (MLRC). Prerequisite: Completion of at least one 300-level French course, placement score, or permission of Instructor. Prerequisites: 82-303 or 82-304.

82-306 Intensive French Language and Culture: Advanced Level  
Intermittent  
Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for French.
82-311 Arabic Language and Culture I
Fall: 9 units
This course aims to build students' knowledge of the Arab world and at the same time promote the development of their linguistic abilities in Modern Standard Arabic (MSA) through reading, writing, speaking and listening. A broad range of literary and nonliterary texts and topics relating to the Arab world and Arabic-speaking peoples are studied. Each iteration of this course focuses on a particular theme, such as Current Issues in the Arab World, Ethnic Groups in the Arab world, Arabic Poetry and Proverbs, Education, Economic and Social Development, etc. Students will be asked to write short essays and give brief oral presentations in class. Prerequisite 82-212 Intermediate Arabic II or approved equivalent.

82-312 Arabic Language and Culture II
9 units
This course is a sequel to 82-311 and also aims to build students' knowledge of the Arab world and at the same time promote the development of their linguistic abilities in Modern Standard Arabic (MSA) through reading, writing, speaking and listening. A broad range of literary and nonliterary texts and topics relating to the Arab world and Arabic-speaking peoples are studied. Each iteration of this course focuses on a particular theme, such as Current Issues in the Arab World, Ethnic Groups in the Arab world, Arabic Poetry and Proverbs, Education, Economic and Social Development, etc. Students will be asked to write somewhat longer essays and give more extensive oral presentations than in 82-311. Prerequisite approved equivalent.

82-313 Readings in Islamic History
9 units
This course focuses on Islamic history and enables students to read authentic historical texts in Arabic written three to five centuries ago and to understand the cultural context that gave rise to these texts. Students also will continue to develop their ability to express their ideas both in speaking and in writing and to develop their listening skills in Modern Standard Arabic. Prerequisite or approved equivalent.

82-320 Contemporary Society in German, Austria and Switzerland
Intermittent: 9 units
This course advances proficiency in communicative and grammatical skills in the German language and knowledge of German-speaking cultures through the study of important events, trends, and people of contemporary Germany, Austria, and Switzerland. Examples will be drawn from literature, newspapers, television, film and other sources. Students will be expected to complete assignments that demonstrate the ability to express critical judgments in both written and oral form, documented through readings and personal research. The course includes a systematic review of German grammar. Prerequisites or permission of the instructor. Prerequisite or with permission of the instructor. Prerequisite or approval equivalent.

82-323 Germany, Austria and Switzerland in the 20th Century
Spring: 9 units
This course advances proficiency in communicative and grammatical skills in the German language and knowledge of German-speaking cultures through the study of important events, trends, and people of the twentieth century in Germany, Austria, and Switzerland. Examples will be drawn from literature, newspapers, television, film and other sources. Students will be expected to complete assignments that demonstrate the ability to express critical judgments in both written and oral form, documented through readings and personal research. The course includes a review of the most troublesome points of German grammar. Prerequisite or permission of the instructor. Prerequisite or approval equivalent.

82-326 Intensive German Language and Culture: Advanced Level
Intermittent
Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for German.

82-327 The Emergence of the German Speaking World
Intermittent: 9 units
The Italian literary theorist Franco Moretti has written that "Germany is a sort of Magic Stage, where the symbolic antagonisms of European culture achieve a metaphysical intractability, and clash irreconcilably. It is the centre and catalyst of the integrated historical system we call Europe." This course is a general introduction to German culture, German history, and German society, with a focus on Germany's role as center and catalyst of the European system. The course is conducted entirely in German. Its goal is to provide students with a basic level of cultural literacy about the German-speaking world. In the course, we will study major trends from the earliest days of German civilization through the middle ages but with primary emphasis on the 18th, 19th and 20th centuries and with a special focus on problems of national, political and cultural identity. Students coming out of the course should have a broad understanding of the various tensions and problems that have characterized German culture and society for the last two centuries. In addition to broadening students' cultural knowledge about the German-speaking world, this course will continue to emphasize the improvement of students' ability to speak, read, write, and listen to German. Prerequisites or permission of the instructor. Prerequisites: 82-320 or 82-323 or 82-324.

82-331 Advanced Chinese I
Fall: 9 units
This course is designed for students who have reached the intermediate level of proficiency in the use of Chinese language. With emphasis on the communicative functions of the language, it aims at generating students' language process competency in all four skills of listening, speaking, reading and writing. More complex language phenomena needed for communication in a variety of discourse will be introduced through texts as well as multi-media programs closely related to various social issues in China to provide students with the necessary knowledge of the language and its background. Classroom discussions will be an important part of the course followed by the practice of writing an essay on topics related to various social issues in China. With Pinyin as a help, students are required to use both the simplified and traditional forms of Chinese characters in their reading and writing. Prerequisite or approved equivalent.

82-332 Advanced Chinese II
Spring: 9 units
A continuation of Advanced Chinese I, this course is designed to train students with the ability to use Chinese language to deal with abstract topics they may encounter in their life. Students will continue to learn more complex language phenomena in order to do exposition, explanation, description and argumentation with the language. These language phenomena will be introduced to students together with their social and cultural background through texts and multi-media programs related to various social issues. Classroom discussions will be the major form of practice. Students will discuss and comment on issues related to family, love, marriage and other human relations as well as the economic situation in the Chinese society by using their language skills in narration, description, comparison, argumentation, etc. Students will also be required to write short articles of 600 Chinese characters on various topics discussed in class. Prerequisite or approved equivalent.

82-333 Introduction to Chinese Language and Culture
Fall and Spring
This course will introduce students to important developments in China's culture and language since the end of the nineteenth century. We will focus on the interactions between Chinese and Western cultural traditions and the historical, social and political contexts in which these interactions evolved. Thus we will explore questions like: What is Chinese culture in the modern world? What is "modern" and what "traditional" Chinese culture? How does high culture interact with folk culture and popular culture? How do education and language policies shape Chinese cultural identities over the last century? What does it mean to be Chinese in a diaspora context? Secondary readings, primary documents, and video material chosen for analysis will provide students with important insights into the diverse factors that have been shaping contemporary Chinese culture. This course is conducted in English with no requirement of prior knowledge of Chinese language for students who take it for 9 units. Students who take this course towards Chinese major/minor must register for 12 units (see prerequisites), and an additional 3 units of Chinese needs to be completed for the extra 3 units. Prerequisites: To register for 12 units, there is a prerequisite of either 82-232 or 82-235 or instructor's approval. No prerequisite for students taking the course with 9 units.
82-334 Structure of Chinese
All Semesters: 9 units
This is an upper-level Chinese course for students who have reached intermediate level of Chinese. It aims at helping students to further develop and refine their Chinese speaking and writing skills. This course will deal with major structural phenomena in Modern Chinese through the study of sample texts. Special emphasis will be given to high frequent errors and individual weaknesses on particular problematic elements and sentence structures that are common among non-native Chinese speakers. After the study of this class, students are expected to have a more comprehensive and systematic understanding of the structure of the language, which will help them lay a solid foundation for their language proficiency. Prerequisite or approved equivalent.
Prerequisites: 82-232 or 82-235.

82-335 Readings in Chinese
Intermittent: 9 units
82335 Readings in Chinese: Traditional Chinese Thoughts and Literature through Comic Books and Animation This course was inspired by a comic book series created by Tsai Chih Chung in the 1980’s, which illustrate canonical works in traditional Chinese philosophy and literature. Ever since it was published, the comic book series has become a great hit in Taiwan and Mainland China, and has been translated into different languages around the world. While its popularity continues to grow among its readers, its wide circulation also raises questions among scholars and critics of traditional Chinese literature and culture. Two questions are usually brought up in the discussion of the value of this comic book series: (1) Are the comic adaptations faithful to the meanings of the original Chinese works? (2) Does the popularity of this comic series really help to promote the understanding and transmission of traditional Chinese culture? One goal of this course is to look into these two questions. In this course, students will be asked to read Tsai Chih Chung’s comic books and their animated adaptations, as well as the English translations of the Chinese canonical texts of philosophy and literature. While enjoying Tsai’s innovative and delightful comic interpretation, students will also need to ponder upon serious philosophical questions along with the early Chinese thinkers, to learn to savor the aesthetic beauty of traditional Chinese literature, and to prepare to share their ideas and discovery to the rest of the class in Chinese.
Prerequisite: 82-232.

82-336 Intensive Chinese Language and Culture: Advanced Level
All Semesters
Transfer credit for study abroad in China, a Chinese-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for Chinese.
Prerequisite: 82-232.

82-337 Mandarin Chinese for Oral Communication
Fall: 9 units
This is an upper-level course focused on the improvement of students’ oral communicative competence and self-expression in Chinese. It is designed for students who have reached intermediate level in reading and writing Chinese but have little knowledge of mandarin Chinese pronunciation, as well as those who aim to further improve their speaking in Chinese. Emphasis will be given to helping students develop the accuracy and fluency which characterize the speech of native Mandarin speakers. Students will be introduced to Pinyin, the phonetic system of Mandarin Chinese, and work to refine and perfect their speaking skills through special attention to different styles, colloquialisms, and dialectal variations of contemporary spoken Mandarin. Course materials will include authentic Chinese TV programs, documentaries, films, recorded materials, and contemporary literary and non-literary texts. Students will be required to participate in intensive speaking activities, such as interviewing native speakers of Chinese, oral presentations, discussions, debates, and special projects. At the end of the course, students are expected to carry on oral communication with native Mandarin speakers in a clearly participatory fashion on topics related to various social issues in Modern China. Prerequisite or approved equivalent.
Prerequisite: 82-232.

82-338 Mandarin Chinese for Oral Communication
Spring: 9 units
This course is designed for students who have reached an intermediate level in reading and writing Chinese, and who wish to promote their oral communicative competence and knowledge of Chinese culture. It is a seminar-type class that relies on active participation from the students. Students will practice various conversational tasks, such as giving presentations, participating in discussions and debates, interviewing, describing, and interpreting. Topics will include current events and cultural trends in the U.S. and China, analysis of Chinese culture and comparisons with other cultures, contemporary Chinese television shows and movies, and other debatable and interesting issues. Prerequisite: Intermediate level in reading and writing Chinese. Permission of the Instructor.
Prerequisites: 82-232 or 82-235.

82-341 Advanced Spanish Transfer Credit
All Semesters
This course number is given to pre-approved advanced courses in Grammar, Composition, Conversation, or other appropriate, advanced coursework taken at a part of a study abroad program, or at another approved institution.
Prerequisite: Completion of 82-242 or an approved equivalent, or prior permission of the Hispanic Studies major or minor advisor, and confirmation of credit upon return.
Prerequisite: 82-242.

82-342 Spain: Language and Culture
Fall and Spring: 9 units
FALL 2012 This course is part of the intermediate 300-level program that forms the introduction to the major or minor in Spanish. It focuses on the cultures of Spain, the autonomous regions, and the creation of a national identity as a reaction to the multiple ethnicities that have inhabited the Iberian Peninsula since ancient times. ¿Qué es España? ¿Cómo es España? To answer these questions we will study important historical moments and issues that have shaped the development of Spain, through language, geography, history, music, art, film and architecture of Spain. Students will explore the diversity of cultures within Spain and their past and present struggles in issues of war, religion, gender, race, class, immigration, among others. In addition to building an understanding of the cultures of Spain, this course advances proficiency in grammatical accuracy and verbal communication. Students are expected to work in groups, participate passionately, give class presentations and communicate fully in Spanish. Class is taught in Spanish. Prerequisites: completion of 82-242, by placement exam, or by permission of the instructor.
Prerequisites: 82-242 or 82-244.

82-343 Latin America: Language and Culture
Fall and Spring: 9 units
FALL 2011 This course explores the notion of Latin American as a heterogeneous socio-cultural formation, instead of as a homogeneous group produced by a common historical-colonial past. We will look at how Latin American identity has been a debated concept part of larger power struggles. We will analyze canonical and contemporary literary and cultural products (films, songs, practices) to understand from where Latin America thinks itself and from where Latin America is read. Students will be able to do readings, engage in debates, do oral presentations and write an independent project about a topic of their interest.
Prerequisites: 82242 or 82244 or by permission of the instructor
Prerequisites: 82-242 or 82-244.

82-344 U.S. Latinos: Language and Culture
Fall and Spring: 9 units
The purpose of this course is to provide review and practice of the four skills: reading, writing, listening and speaking at the advanced level, in Spanish. All work in this course, in the four skill areas, will be stimulated by and be the product of an advanced introduction to and analysis of the cultures and histories of the Hispanic peoples in the United States of America. Many of these people have been and are native born; others are descendants of natives and/or colonizers who resided in North America prior to the arrival of Anglo-Germanic peoples. Many have migrated from Mexico, the Hispanic Caribbean, Central and South America, and Spain during the past two centuries, for economic and/or political reasons. Still others have migrated under special circumstances, as exiles escaping from repressive regimes or from wars in their homelands. Our exploration of U.S. Latino history and culture will compare and contrast the experiences of Hispanics from all three of the above-described categories and analyze the dynamic tension amongst them, with other minority groups, and with the mainstream society.
Prerequisite: Completion of the intermediate level equivalent or permission of the instructor.
Prerequisites: 82-242 or 82-244.
82-345 Introduction to Hispanic Literary and Cultural Studies
Intermittent: 9 units
FALL 2012 82-345 Hispanic Literary and Cultural Studies: IMMIGRATION, NATION, AND DIASPORA In this class, we are going to consider the various reasons for and responses to immigration in the Spanish-speaking world. Human movement arises in a variety of contexts, including political or religious persecution and war, as well as the institutional violence of hunger and poverty. Immigration and exile have had a tremendous impact in Latin America, Spain, and the United States, resulting in richly diverse and complex cultures. We will examine the phenomena of immigration and exile across different socio-political moments and several different countries. Through an examination of the cultural production relating to and stemming from immigration, we will gain better insight into the Spanish-speaking world, as well as into the effect that immigration has at both an individual and an institutional level. We will pay particular attention to immigration under the current pressures of globalization and transnational flows. Further, we will discuss how the concepts of nation and identity are both affected by and affect the process of immigration. Materials will include but will not be limited to novels, poetry, short stories, music, film, essays, and newspaper articles. Our class will be student-centered, and thus highly interactive. Students will continue to develop their language skills (speaking, listening, reading, and writing). It is also a goal of this course to stimulate analytical thinking, and to promote the close readings of texts directed by argumentation and well-structured insights. Prerequisite: Completion of two out of three 300-level Hispanic Studies courses (82-342, 82-343, or 82-344) or permission of the instructor. Prerequisites: 82-342 and 82-343.

82-346 Intensive Spanish Language and Culture: Advanced Level
Intermittent
Transfer credit for study abroad in a Spanish-speaking country or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for Spanish.

82-346 Literacies Across Language and Culture
This course examines differences and similarities in the ways literacy is learned and used in diverse languages and cultures. By clarifying the distinct characteristics of spoken and written communications, we will first analyze what was made possible through the invention of writing, and in so doing, explore the social and cognitive consequences of literacy. We will then scrutinize literacy utilization in a variety of cultural contexts, as well as its collective impacts on the users. Lastly, through systematic comparisons of literacy education, we will identify the social, cognitive, linguistic factors, which shape literacy in particular cultural contexts. Prerequisite: None.

82-361 Introduction to Italian Culture
FALL 2011 82-361 INTRODUCTION TO ITALIAN CULTURE 9 units
This is a course in Italian culture and conversation with a streamlined review of grammar. The course deals with the social, political, economic, demographic and cultural issues of contemporary Italy. At the same time letters are drawn between past and present, evidencing the importance of tradition and history in Italian society. The course will be conducted in Italian with occasional English. Prerequisite or permission of the instructor. Prerequisite: 82-262.

82-362 Italian Language and Culture
Spring: 9 units
SPRING 2011 "ITALY AS SEEN THROUGH FILM" According to Federico Fellini "A different language is a different vision of life". This course will offer a cultural journey that will enrich the student’s perspective on Italy and the Italians. It will be a view of contemporary Italy through the lens of Italian filmmakers. Screenings of movies in the Italian language will be followed by a "cinéforum", a roundtable discussion and critique of the major themes introduced by the director. The films, forums, and background research will serve as a vehicle for developing and improving all aspects of communication in Italian from the spoken to the written language. Film selections will range from the classics to recent popular hits. The course will be conducted in Italian. Students will expand and enrich their vocabulary and grammar knowledge through exercises and essays related to the movies screened. The course will be conducted in Italian. Prerequisite or permission of the instructor. Prerequisite: 82-262.

82-371 Advanced Japanese I
Fall: 9 units
A two-semester course sequence (82-371, 82-372). This course emphasizes the acquisition of an advanced level of communicative language proficiency by immersing students in authentic cultural explorations. Curriculum includes authentic reading texts, audiovisual materials, interviews with native speakers, and viewing and summarizing Japanese films that depict current Japanese society and cultural trend. The course also provides an individualized learning environment throughout the term in improving students’ language skills and cultural proficiency. Students may pick a topic of personal interest for their term project thesis. Prerequisite or approved equivalent. Prerequisite: 82-272.

82-372 Advanced Japanese II
Spring: 9 units
A sequel to Advanced Japanese I (82-371). This course continues to further improve the acquisition of the advanced level communicative language proficiency by immersing students in authentic cultural explorations. Curriculum includes authentic reading texts, audiovisual materials, interviews with native speakers, and viewing and summarizing Japanese films that depict current Japanese society and cultural trend. The course also provides an individualized learning environment throughout the term in improving students’ language skills and cultural proficiency. Students may pick a topic of personal interest for their term project thesis. Prerequisite or approved equivalent. Prerequisite: 82-371.

82-373 Structure of the Japanese Language
Intermittent: 9 units
This course examines the basic Japanese grammar covered in Elementary and Intermediate Japanese by comparison with English and aids students in systematizing their knowledge of Japanese. After a brief discussion of the overall differences between the two languages and initial training to analyze them cross-linguistically, it deals with specific areas of grammar that exhibit pervasive structural and semantic differences and serve as exercises for cross-linguistic analysis. On the basis of the discussion and exercises in class, students are required to gather and analyze relevant Japanese data, thereby facilitating their understanding of the grammar point in question and developing their analytical skills. This course is taught in Japanese. Corequisite: 82-272.

82-374 Technical Japanese
Intermittent: 9 units
This course is the first course in Technical Japanese. It will introduce students to expository styles in Technical Japanese. It will explore technical terms and concepts in electrical engineering, computer science and computer engineering. In addition, it will enable students to acquire knowledge of some kanjis used frequently in Technical Japanese. This course will also provide students with practical information as well as cultural information in the contexts of Japanese science and technology. Furthermore, the students are given an opportunity to work with a Japanese student/researcher for a final project. Prerequisite or approved equivalent. Prerequisites: 82-271 or 82-272.

82-376 Intensive Japanese Language and Culture: Advanced Level
Intermittent
Transfer credit for study abroad in Japan or other approved program at the advanced level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-378 Japanese Conversation Analysis
Intermittent: 9 units
Through analysis of various registers of the Japanese Spoken language, this course aims to provide analytical tools for Japanese conversational analysis and to provide opportunities to students to practice high proficiency level of oral communication skills such as formal speech, job interviews, and business communication. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as speakers’ perspectives, attitudes and emotions. This course is offered in Japanese. Prerequisites or approved equivalent. Prerequisite: 82-272.

82-380 Independent Study in Second Language Acquisition
Spring
An opportunity for students who wish to pursue independent supervised study in second language acquisition (SLA). In conjunction with a faculty member, students will arrange a program of study to explore aspects of SLA. Prerequisite: Permission of the Instructor.
82-383 Second Language Acquisition: Theories and Research
Fall: 9 units
This course provides an introduction to research and theories in Second Language Acquisition (SLA). Processes that underlie the learning and use of second languages are examined from four perspectives: 1) as linguistic knowledge, 2) as a cognitive skill, 3) as a personality-mediated process, and 4) a socio-culturally mediated process. Factors examined include: age-related differences, the influence of the first language, the role played by innate (universal) principles, the role of memory processes, attitudes, motivation, personality and cognitive styles, and formal versus naturalistic learning contexts. Issues that arise from the course readings are investigated through practical experience in applying theoretical knowledge to small-scale empirical research projects. Students are also provided with opportunities to consider the relevance of these issues to their own language learning experiences. 82-260 "Learning about Language Learning" is strongly recommended. Prerequisite: 82-280.

82-384 Language and Culture: Language in its Social Context
Intermittent: 9 units
The focus of this course is an examination of the dynamic role that language plays in a multitude of social contexts throughout the world. The goal of the course is to develop students' sensitivity and awareness to the dual role of language both as a reflection of prevailing social attitudes and as a force that serves to perpetuate many social attitudes and roles. This complex relationship between language, society, culture and personal identity will be demonstrated by examining language use in a wide variety of speech communities throughout the world. The course will consider numerous diverse topics, all of which demonstrate implicit cultural differences and attitudes as manifested through language use. Examples of topics to be considered include standard versus vernacular languages; dialects and variation, language attitudes, bilingualism and multiculturalism in the United States and throughout the world; diglossia; language, literacy and education; non-verbal aspects of language use; gender-based differences in language and culture; socio-linguistic variables in the ethnography of speaking; language loss and language maintenance; politics, language planning and language policy and the impact of languages in contact. The course will be taught on a seminar basis and will involve regular fieldwork activities to bring the themes of the course to life. Prerequisite: None.

82-385 Language Across the University
Fall and Spring
Language credit may be attached to any course, independent study, or project unit for which a student receives content-area academic credit. The program is available at the discretion of the responsible content-area faculty, who should be sufficiently skilled in the chosen language to be able to evaluate the technical content of a student's work. The student, content-area faculty and language faculty negotiate a plan for the semester's work, designed to consume approximately three hours per week for three units of academic credit. The course may be repeated on multiple occasions. Prerequisites: Intermediate level language proficiency or above and permission of a content-area faculty member and the Department of Modern Languages.

82-387 The Film Festival
Intermittent: 9 units
The Film Festival is an annual offering which rotates between the Departments of English, History and Modern Languages, with a different annual theme selected by the instructor. A core element every year is the study of the Film Festival itself as a global cultural and economic phenomenon. Students in the course will also participate in the planning, promotion and running of a public film festival based on the annual theme and presented to the Carnegie Mellon and Pittsburgh film communities in McConomy Auditorium. Prerequisite: None.

82-388 Understanding Second Language Fluency
Fall: 9 units
This course examines differences and similarities in the way literacy is learned and used in diverse languages and cultures. We will first examine the cognitive and social consequences of literacy by analyzing the major characteristics of spoken and written communications. We will then compare literacy practices in a variety of cultural contexts and explore how literacy utilization alters its collective impacts on the users. Finally, through systematic comparisons of literacy education, we will identify the social, cognitive, linguistic factors directly affecting literacy development in different cultural contexts. Prerequisite: None.

82-391 Advanced Russian I
Intermittent: 9 units
This course seeks to enhance listening-comprehension skills while perfecting the linguistic and stylistic practices of advanced students. Intensive study is made of varied literary, journalistic and colloquial texts in audio-visual and print media. Focus is on rapid vocabulary expansion as well as correction of high frequency syntax errors that persist beyond the intermediate level. Practice with online resources, additional to three class hours per week, is mandatory for the evolution of aural/oral fluency. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite or approved equivalent Prerequisite: 82-292.

82-392 Advanced Russian II
Intermittent: 9 units
The second part of a two-semester course sequence Prerequisite or approved equivalent. Prerequisite: 82-391.

82-396 The Faust Legend at Home and Abroad
Intermittent
This course introduces students to the basic outlines of the Faust story, and examines its nineteenth- through twenty-first-century manifestations in a variety of European, Russian and American novels, plays, films and operas. On the assumption that cultures reveal something distinctive about themselves by the particular way in which they adapt the legend, this course aims to discover how and why these Faustian works of art respond and contribute to the social, political and historical context in which they are produced. On what is the persistent appeal of the Faust legend based? To what needs does it speak? How does the history of its own, continual reemergence affect the meanings it communicates? Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

82-397 Russia's Demons
Intermittent
Demons and devils, ghosts and goblins, witches and werewolves: Russian literature, art and music are riddled with them. Where have they come from and why have they stayed? Under what conditions has Russian life conjured them, and what has their power been for creating conditions of their own? This course aims to find out by peering into the netherworld of demonic fantasy by the light of Russian social history from the nineteenth century to the current day. The core of the course is comprised of readings drawn from the literature of Pushkin, Lermontov, Gogol, Dostoevsky, Bely, and Bulgakov. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian. Prerequisite: 82-292.

82-399 Special Topics Russian
Fall and Spring
This course focuses on further development of the linguistic and stylistic practices of advanced students based on cultural analysis of Russian literature. Focus is on rapid vocabulary expansion as well as correction of high frequency syntax errors that persist beyond the intermediate level. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite or approved equivalent.

82-401 French Popular Song
Intermittent: 9 units
This class will look at the phenomenon of popular song in a francophone context. We will adopt multiple points of view, including not only song as music and lyrics, but song as an event in a socio-historical context, as well as song as a culturally specific manifestation of high cultural tension, as represented by the history of the Faust legend. On what is the Faust story based? How does the Faust legend reflect the history of Russian society? How does the Faust story reflect the history of Russia? Prerequisite: 82-292.

82-402 French Popular Song II
Intermittent: 9 units
This course continues the examination of popular song in a francophone context. Special attention will be given to the development of the Faust legend in Russian literature. Focus is on rapid vocabulary expansion as well as correction of high frequency syntax errors that persist beyond the intermediate level. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite or approved equivalent.
82-404 Francophone Realities: Africa
Spring: 9 units
This course introduces students to the political and sociological histories of former African colonies. Authors will vary by offering. The literary component of the course involves analyses of francophone authors, examining their roles in the written medium as they attempt to explore colonialism and its effects on Africa. Prerequisite: 82-303 and 82-304 or approved equivalent.

82-406 Intensive French Language and Culture: Advanced Level
Special Topics
Spring: 9 units
Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for French.

82-407 The Arts in Society
Intermittent
The number 82-407 is a repeating number that refers to a sequence of European Studies core courses entitled "The Arts in Society" followed by the course name: "Theaters of Love," "French Modernism," and "Theater and Lyric in the 20th Century". Each course in the 82-407 sequence explores a major theme of modernity and a range of works across cultures. Theater and Lyric in the 20th Century focuses on the dimensions of the subject after Romanticism. The course will concentrate on some of the works that transformed modern theater. Readings will include Brecht, Artaud, Beckett, Genet, and excerpts from a range of European and American authors. Works studied include plays, operas, songs, poems, and writings about avant-garde theater. We will view films, filmed performances, and adaptations by a number of directors, including Chaplin, Linder, Pañst, Genet, Brook, Prévert/Carné, Beckett, Renoir, Truffaut, Rivette, Godard, Antonioni, and van Peebles. The focus of the course is on the cultures of Western Europe and the U.S., with an emphasis on French, Anglo-Irish, and German works. All readings are in English. Total enrollment limited to 25.

82-408 Matisse, Chagall, Picasso & Their Contemporaries: Art & Museums on the Riviera
Intermittent
This course examines the lives and work of the major 20th century artists (Chagall, Cocteau, Léger, Matisse, Picasso and Renoir) as well as some of their contemporaries who are prominently associated with the art of the Riviera. Considering the artists’ personal stories, the course provides a "social art history" and a multidisciplinary focus which includes an understanding of the historic context, geographic setting, and artistic milieu in which these artists lived and worked, complemented by a conceptual exploration of what a museum is, its physical space and its role in society. The course will be taught in English with assigned readings and related assignments in French for French minors and majors. Prerequisite: None.

82-410 Advanced Research in French Francophone Language and Culture
Fall and Spring: 9 units
In this course, students will study the core curriculum of the 82-305 course, which is to say, a focus on culture through language variation in spoken and written forms of French. Readings, videos, web use, and in-class conversations involve phonological and sociolinguistic aspects of the French language and language change; its use regarding different registers and regional languages within France; the question of social identity through language; immigration and generational issues; and an exploration of the distinctive francophone uses of the French language. In order to achieve these goals, students do personal work on improving their control of the French phonological system, and discuss current issues in France and francophone regions/countries by using multimedia tools available in the Modern Language Learning Resource Center (MLRC). For students in the advanced level of this 305 core curriculum, a research project showing the application and intellectual development of one or several of the concepts described above is required. The project involves a written work of a minimum of 15 pages plus bibliography and a 10-minute oral presentation to the class, both in French. Prerequisites: 82-303 or 82-304.

82-415 Topics in French and Francophone Studies
Intermittent: 9 units
FALL 2012 "Cities and Suburban Spaces in French and Francophone Literature" This course takes the form of a journey from 19th century Paris to the postcolonial African metropolis, with several stops along the way in French Indochina, the Caribbean city, and the troubled French banlieues. Drawing from the study of the ‘quotidien’ by Georges Perec and Michel de Certeau, as well as urban, gender, and postcolonial theories, we will look at the production of identity, memory, and gender within urban spaces. We will also explore the way these categories influence the fabric of the city. Readings will include Emile Verhaeren’s Des Villes Tentaculaires, Calixthe Beyala’s “Tu t’appelles Tangara, Duraf”, Un Barrage contre le Pacifique, and Faïza Guen’s Kiffe kiffe demain. The course will also examine the filmic representations of cityscapes in Fabrice Genestal’s La Squale and Euzhan Palcy’s Rue Cases-Nègres. In line with the spirit of these explorations, students will be encouraged to use a variety of supports and media for their presentations. Pre-requisites: Completion of 82-303, 82-304, and 82-305 (or their equivalents). Prerequisites: 82-303 or 82-304 or 82-305.

82-416 Topics in French and Francophone Studies
Spring: 9 units
Spring 2012 This course looks at the phenomenon of popular song in a francophone context. Genre will be used as the primary course architecture, including variétés, chanson d’auteur, rock & yé-yé, rap, world, folk and spoken word. Multiple points of view will be adopted, however, including not only song as music and lyrics, but also song as a socio-historical event, as performance, as an indicator or measure of cultural attitudes and values. The focus will be on technical innovation in instrumentation, recording, sound reinforcement, and distribution. At the end of the course, students will have a familiarity with the primary currents of expression in popular music in the francophone world, and will have acquired some of the critical and analytical tools used in musicology, sociology, and cultural studies for research in this expanding domain. Pre-requisites: Completion of at least 82-303 (French Culture) and 82-304 (The Francophone World) AND PREFERABLY 82-305 (French in Social Context). OR the instructor’s permission. Excellent reading ability in French and a good ability to express oneself both orally and in writing are essential. Prerequisites: 82-303 and 82-304.

82-420 German Classical Literature
Intermittent: 9 units
This course, conducted entirely in German, provides a basic introduction to the literature of Enlightenment, Sturm und Drang, and classicism in Germany during the second half of the eighteenth century and at the beginning of the nineteenth century. Classical literature appeared in Germany at a later date than in the other major European countries; for this reason German classical literature tends to be more accessible linuistically to contemporary readers than some other classic literatures. The course will begin with the remarkably lucid and relevant work of Lessing, in particular his plays Emilia Galotti and Nathan der Weise—both programmatic statements of Enlightenment rationality and critical bourgeois consciousness. We will then move on to the brief but important Sturm und Drang period, exploring Goethe’s revolutionary novel Die Leiden des jungen Werther, Schiller’s radical drama Die Räuber, and Lenz’s disturbing play Der Hofmeister. The focus will be on Sturm und Drang as a uniquely German phenomenon, and on the questions for its rapid development and quick demise. Our exploration of classical literature will culminate with Goethe’s Faust I, one of the great masterpieces of western literature and probably the most celebrated and influential work in the German literary canon. We will also devote time to close reading and aesthetic appreciation of some of Goethe’s most beautiful poems. An examination of Schiller’s letters Über die ästhetische Erziehung des Menschen will round out our exploration of German classicism as an idealistic aesthetic movement. Students will be asked to complete five brief writing assignments over the course of the semester, and to take midterm and final examinations. Prerequisite: Completion of 82-325 or approved equivalent.

82-421 German Literature of the Nineteenth Century
Intermittent: 9 units
This course, entirely in German, focuses particularly on short fiction such as fairy tales. The nineteenth century was the heyday of Romanticism, in which authors told fantastic tales like E. T. A. Hoffmann’s “The Nutcracker and the Mouse King,” which was subsequently turned into a famous Christmas ballet by the Russian composer Peter Ilyich Tchaikovsky. Germany is particularly famous for its Romantic culture, and in fact tens of thousands of people all over the world get married every year to the music of German Romantic composers like Richard Wagner and Felix Mendelssohn (“Here Comes the Bride” and the Wedding March, respectively). For many, Romanticism achieved its purest expression in Germany. Students will be asked to participate actively in discussions of the reading, to complete a series of short papers, to lead classroom discussion on one day, and to complete a final project of their choice. Prerequisite or approved equivalent. Prerequisite: 82-325.
82-422 German Literature of the Early Twentieth Century
Intermittent: 9 units
From its inception in 1871, The Second German Empire promised to be an industrial, cultural and military powerhouse on the continent of Europe. But when the hand of the iron Chancellor, Otto von Bismarck, was removed from the helm by Kaiser Wilhelm II in 1890, the “New Germany” charted a course that would lead to a catastrophic conflict with its neighbors to the west (England and France) and to the east (Russia). This course examines works by some of the major authors of this period (Mann, Wedekind, Hauptmann, Rilke, Kafka) as well as modern film adaptations of their works. Readings will also include seminal thinkers such as Nietzsche, Freud, Marx and Einstein. And, we will engage the visual arts through a survey of the German Expressionists. The purpose of this course is to examine a wide variety of “cultural artifacts” against the backdrop of the political, social, and economic currents of the period. Prerequisite or approved equivalent. Prerequisite: 82-325.

82-425 Topics in German Literature and Culture
Intermittent: 9 units
Fall 2012 This course, conducted entirely in German, will explore five contemporary German-language bestsellers, ranging from Patrick Suskind’s Das Parfum through Bernhard Schlink’s Der Vorleser to Daniel Kehlmann’s Die Vermessung der Welt. We will be asking what made these novels so popular in the German-speaking world and internationally. Students will be required to read and discuss the five novels, to actively attend and participate in class, to complete three writing assignments as well as a final project (in German), to lead discussion on a particular day, and to take a midterm and final examination. Prerequisite: Completion of 82-325 or approved equivalent. Prerequisites: 82-325
Prerequisites: 82-320 or 82-323 or 82-327 or 82-426.

82-426 Topics in German Literature and Culture
Intermittent: 9 units
Spring 2012 82-426 A: Germany Tells Its Stories Deutschland erzählt! / Germany Tells Its Stories 82-426 A The way a nation tells its stories tells us something about its people and the times in which they live. How does the individual relate to the society and the Zeitgeist in which she finds herself? How does the society’s past and its prospects for the future shape what is in the present? In this course we will read and discuss German short stories from the nineteenth and twentieth centuries. All readings, discussions, and written assignments will be in German. 82-426 B East German Socialist Culture This course, which will be taught in English, provides an overview of East German socialist culture from the foundation of the German Democratic Republic out of the ruins of World War Two in 1949 to the end of the East German state in 1990. The course will address the question of what “socialist realism” meant in the East German context and how East German culture sought to come to terms with the legacy of the Nazi dictatorship and the necessity of the Cold War alliance against the spread of “vulgarization of German, and the fact that many East German citizens did not share German Communists’ dreams of a better future.” Prerequisite or approved equivalent. Prerequisites: 82-323 or 82-324 or 82-325.

82-427 Nazi and Resistance Culture
Spring: 9 units
How could the land of Goethe and Beethoven also have produced Hitler and the Holocaust? This is a question that has frequently been posed to German: Germany has arguably been the dominant country in Western musical development since the sixteenth century; it has also witnessed an extraordinary flowering of literature, philosophy, and the visual arts. This course, conducted entirely in German exclusively for students with superior German-language skills, will explore what happened to German culture from 1933 to 1945. In particular, it will examine the Nazi assault on modern art and the artistic response of the German and foreign resistance to Nazi tyranny. Arts explored will include literature, film, music, and the visual arts. We will read from the works of a variety of writers, including A–don von Horvath, Anna Seghers, Bertolt Brecht, Adolf Hitler, Albert Speer, Hanns Johst, Paul Celan, and Wilfrid Bade. Film will also play a major role in the course, and students will be required to view (outside of class) and discuss six Nazi-era films, including Veit Harlan’s infamous anti-Semitic Jud Süß, Rolf Hansen’s Nazi musical romance Die große Liebe, and Charlie Chaplin’s The Great Dictator. Students will be required to lead a classroom discussion, to write a major essay, to write a “Protokoll,” to complete all required readings, and to participate actively in classroom discussion, in German. Prerequisite or approved equivalent. Prerequisite: 82-325.

82-428 History of German Film
Intermittent
This course is a chronological introduction to one of the world’s greatest cinema traditions: German cinema. It moves from the silent cinema of the 1910s to the Weimar Republic, when German cinema represented Hollywood’s greatest challenger in the international cinema world. It then addresses the cinema of Hitler’s so-called “Third Reich,” when German cinema dominated European movie theaters, and moves on to the cinema of divided Germany from 1949-1989, when cinema in the socialist east and cinema in the capitalist west developed in very different ways. In the final week of the semester, we will address German cinema in the post-unification period, which has experienced a revival in popularity and interest. The two historical foci of the semester will be the Weimar Republic, the classic era of German cinema, and the era of the so-called “New German Cinema” of the 1970s and 1980s, when major German directors developed radical new approaches to cinema and critiques of Hollywood. Among the great directors focused on in the course of the semester will be Friedrich Wilhelm Murnau, Fritz Lang, Leni Riefenstahl, Wolfgang Staudte, Werner Herzog, Wim Wenders, and Rainer Werner Fassbinder. No knowledge of the German language is required for this course; most of the films will be in German with English subtitles. The course will be cross-listed in the departments of Modern Languages, English, and History. Students will be required to attend class, including all film screenings, to actively participate in discussion, to write a 15-page term paper on a topic related to German cinema history, and to take two mid-term examinations. Prerequisite: 82-324.

82-429 German Reading and Translation Workshop: Undergraduate
Intermittent: 9 units
This course will explore different models of translation. Individual and group work will focus on translation of literary pieces, journal articles, critical essays, materials from the internet and other sources. The workshop will also offer an advanced-level grammar and stylistics review, a vocabulary builder and increased exposure to German language and culture. Prerequisite or permission of the Instructor. Prerequisite: 82-324.

82-431 China and the West
Intermittent: 9 units
This course takes a look at the multifaceted relationship between China and the Western world from Marco Polo’s time to the present. The focus will be on how people in China and the West imagined each other in different times of history and in what ways some historical events and figures, as well as concepts and cultural practices are interpreted differently from Chinese and Western perspectives. Students are expected to reach a deeper understanding of the complexities of cultural interactions and their implications for the diverse world in which we now live. The students will read a rich collection of scholarly writings, and the class will be conducted primarily in discussion format. The class is conducted in English and Chinese. Students will complete readings in both English and Chinese. Assessment will be based on participation in the discussion, student presentations, and written assignments (including research papers, book reviews, and translations). Prerequisites: 82-332, or instructor’s approval.

82-432 Popular Culture in China
Intermittent: 9 units
his class is a general introduction to various aspects of popular culture in contemporary China. Students will gain a critical understanding of common people’s perspectives and experiences with China’s revolutionary past and its contemporary global economy through fiction, film, music, newspaper and magazine articles, internet discussion forums, and other forms of visual and written materials. The class is conducted in Chinese, supplemented by occasional scholarly writings in English. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332.

82-433 Topics in Contemporary Culture of China
Fall: 9 units
SPRING 2012 This course introduces the media landscape of the People’s Republic of China with the goal to foster an understanding of how Chinese media work and what role they play in Chinese society. We will explore topics such as the legal and institutional framework of both old and new media, changes in the media landscape during the last decade, the training and self-consciousness of Chinese journalists, or the activities of non-establishment bloggers. Classroom activities will include discussions and student presentations. Assessment will be based on class participation, student presentations, translations and written assignments. The course will only be conducted in Chinese and requires advanced level of Chinese. Prerequisite: 82-332 or instructor’s approval. Prerequisite: 82-332.

82-434 Religion and Culture in China
Intermittent: 9 units
This course is designed to introduce students to the main features of Chinese religion and culture. We will begin with a survey of religions in China, including Buddhism, Taoism, and Confucianism. We will then discuss the role of religion in Chinese society and politics. Finally, we will examine the relationship between religion and culture in China. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332.

82-435 is China and the World
Intermittent: 9 units
This course examines the interactions between China and the world, focusing on how China has been perceived by the West and how China has perceived itself in relation to the West. We will explore a wide range of topics, including political, economic, and cultural exchanges between China and the West. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332 or equivalent. Prerequisite: 82-332.
82-434 Studies in Chinese Traditions
Intermittent: 9 units
Course description: This course aims at helping students to obtain a general idea of Chinese history from 5000 years ago, understand the basic philosophical ideas of Confucianism and Daoism so that they will be aware and understand how Confucianism and Daoism have influenced the traditional Chinese ways of thinking. Students will also learn to use Chinese to analyze and comment both orally and in written form the pros and cons of the traditional Chinese ways of thinking and the differences between people's ways of thinking in Chinese culture and those in another culture. Materials for this course will be selected from classical works on Confucius teachings, classical poems, modern prose writings, excerpts from Chinese novels, etc. The themes will focus on Chinese history, basic philosophies of Confucianism and Daoism and their influence on the ways of thinking in the daily life of Chinese. Specifically the materials will deal with such issues as traditional Chinese views on study and education, career, family, human relations with nature, self-cultivation and women. Prerequisite: 82-332.

82-436 Introduction to Classical Chinese
Intermittent: 9 units
This course is designed for students who have reached the advanced level of Modern Chinese and would like to promote their knowledge and skills in reading Classical Chinese, a language shaped in the latter half of the first millennium B.C. which still persists as a living medium of expression today. The course aims to introduce students to the basic syntactic patterns of Classical Chinese and the most frequently used Classical Chinese vocabulary. In the course, we will read representative selections from ancient Chinese texts, chosen for their historical value, beauty, and influence on later writers. With this knowledge and training, students will be sufficiently equipped to read the Chinese Classics and will gain a deeper understanding of the history of Chinese civilization, culture and language. Moreover, knowledge of Classical Chinese will help students read and understand sophisticated modern Chinese texts, which make frequent use of Classical allusions and constructs. Prerequisite or approved equivalent Prerequisites: 82-332 or 82-337 or 82-338.

82-439 Modern China Through Literature
Intermittent
This course introduces major Chinese writers and literary works in the twentieth century, emphasizing the intricate relationship between literature and modern China's social, political, and cultural changes. Students will learn to develop analytical skills to appreciate the aesthetic values of Chinese literary works and to explore the major issues of modernity in relation to tradition, gender, nation-state, and revolution. The class will be conducted primarily in discussion format. Students are expected to read all Chinese literary works in English translation, but Chinese majors and minors who take this course for extra language credits must read some selected pieces in Chinese original and do some writings in Chinese. This is a variable unit course (9, 12). There is no prerequisite for students who take it for 9 credits. The prerequisite for students who take this class for 12 units (for extra language credits) is 82-332 or equivalent.

82-440 Studies in Chinese Literature & Culture
Fall: 9 units
Fall 2011 Through close reading of a 17th-century Chinese literary masterpiece, Strange Tales from a Chinese Studio (Liaozhai zhiyi, &#32842;&#25995;&#24535;&#24322;/&32842;&#40779;&#24535;&#30064;), this course invites students to probe into the richly bizarre and heterogeneous world of ghosts and anomalies that constitutes an important aspect of Chinese culture. A large selection of strange tales in Chinese will be introduced throughout the semester, whose contents range from sketchy notes about outlandish figures and creatures to lengthy tales about bewitching dreams, terrifying ghost haunting and affecting stories of fox romance. In addition, students will also be asked to read academic writings in English about ghost literature and culture in traditional China. These writings provide useful sources for students to look into the special nature of the concept of ghost in traditional China, as well as the cultural mindset that motivated the composition, collection and circulation of the ghost stories at that time. By the end of the semester, students are expected to: (1) Significantly improve their reading and writing skills in modern Chinese, and develop basic reading knowledge of classical Chinese. (2) Develop interpretative and analytical skills that are crucial for reading and understanding traditional Chinese literary stories. (3) Become familiar with traditional Chinese ghost literature and culture, and acquire basic knowledge of their origin, history and influence on Chinese culture. Prerequisite: 82-332.

82-441 Studies in Peninsular Literature and Culture
Intermittent: 9 units
FALL 2012 “Pícaro's body and soul: past, present, here and there” This course will explore the main character of the Picaresque novel: the Picaros and the Picaras. It will establish a dialogue between the Picaro's body and soul and its role in national politics and religious discourse. Students will study the origins of the Picaresque novel in Medieval and Golden Age Spanish Literature. They will also analyze the failed attempts to define the Picaresque as a contained canon of literature, and thus will explore the Picaro’s survival and adaptations throughout literature, time and across the Americas. This class will be structured as seminar and students will be responsible for presenting readings in class. The class will include literary texts, critical theory articles and several films. This course is taught in Spanish and a final research paper in Spanish is required. Prerequisite: Completion of 82-345 or permission of instructor. Prerequisite: 82-345.

82-442 Analysis of Spoken Spanish
Intermittent: 9 units
This course is an introduction to Spanish Linguistics. The main goal of the course is to provide students with the opportunity to learn the tools of linguistic analysis and to apply them to the study of Spanish. Attention will be given to different levels of analysis in linguistics including phonetics, phonology, morphology, and syntax. Class time will be divided between lecture, problem-solving exercises, and discussion. Students will have the opportunity to write and present a research paper in specific areas of Spanish linguistics according to their interests. Prerequisite or permission of the instructor. Prerequisites: 82-342 or 82-343.

82-443 Spanish Reading and Translation Workshop
Intermittent: 9 units
This course is of interest to advanced Spanish majors and minors as well as non-specialists seeking to develop reading and translation skills in Spanish. The course will be conducted as a workshop to allow different populations to participate in the class. There will be an emphasis on both individual and group work, different theoretical models of translation and literary pieces, journal articles, critical essays and materials from Internet news services and bulletin boards. For students with advanced Spanish background (major & minors), the reading and translation workshop will offer an advanced-level grammar and stylistics review, a vocabulary builder and increased exposure to Hispanic language and culture. Prerequisite: For Hispanic studies majors and minors, completion of all 300-level coursework or permission of the instructor. Prerequisites: 82-342 or 82-343 or 82-344 or 82-345.

82-444 The Structure of Spanish
Intermittent: 9 units
Spring 2012 82-444 Discourse analysis in Spanish Overview: This course will provide students with a theoretical framework and analytic tools to investigate how Spanish speakers represent, construct and transform their social worlds. In particular, we will focus on language as a social practice through which power relations are maintained or challenged. We will analyze a variety of spoken and written texts to explore the discourse-semantic and lexico-grammatical features that Spanish users deploy to make meanings and negotiate understandings. This analysis will later be interpreted from an interdisciplinary perspective drawing on social theory and history. The course is offered in Spanish. Prerequisite: 82-345.

82-445 U.S. Latino Literature
Intermittent: 9 units
This course proposes to problematize socio-political and historico-cultural issues concerning U.S. Latinos and Hispanic immigrants in the United States. This will involve the analysis and application of assimilation, transculturation and bilingualism theory, and rhetorical/translational problems of the material under examination. Also of interest will be an ongoing class discussion of Latinos/Hispanics in history, the media, entertainment, politics and education. We shall also discuss the "borders," geographical, political and societal, that may or do exist between U.S. mainstream society, Latinos and Hispanic immigrants and strategies employed by hypenated-Americans for overcoming, subverting or undermining this situation. Material for the course will include literature, film, essays and music by and about Latinos and Hispanics in the United States. Prerequisite or permission of the instructor. Prerequisite: 82-345.
This course will focus on political drama from Spain. The themes of tyranny, oppression, freedom, and honor will be examined in works by Spanish playwrights such as Miguel de Cervantes, Lope de Vega, Calderón, the Duke of Rivas, Alfonso Sastre, and Antonio Bueno Vallejo. Special attention will be given to the social and historical contexts of the works. Films and critical articles will complement the study of the primary texts. Readings, class discussions, and all assignments will be in Spanish. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisite: 82-345.

This course permits in-depth, 400-level study in the following courses: 82-342 Spain: Language and Culture, 82-343 Latin America: Language and Culture, and 82-344 U.S. Latinos: Language and Culture. Students will meet with the regularly scheduled 300-level class, read additional texts, and produce research assignments as agreed upon by the Instructor and student. Focus is on a deeper understanding and individualized research of the course topics. Prerequisite: By permission of the instructor only.

This course is an overview of contemporary Latin American “texts” dealing with issues of historical representation, autochthonous heritage, popular culture and gender roles. By “texts” we shall understand conventional and unconventional literary material, film, art, slides and music. The course will explore formal and “rhetorical” problematic, as well as the relationship between fiction and imaginary solutions to real cultural and political conflicts. We shall consider the functions of myth and history in Latin American society and the revisionist role of contemporary texts. We shall also examine the categories and implications of historized fiction and “literaturized” history with particular attention to the power dynamic present in the segregation of the traditional disciplines which are History and Literature, conceived institutionally as reality and fiction, respectively. Prerequisite or permission of the instructor.

Prerequisite: 82-345.

This course offers a survey of some of the most popular comics and graphic novels from the Hispanic/Latino world, and it provides the skills for reading and examining multiple examples of these works critically as cultural artifacts in terms of what they say and how they say it. We will use these texts to investigate Spanish, Latin American, and Latino popular culture, narrative, history, and society; their connections with literary texts, socio-historical and cultural contexts, and economic systems; how issues of race, ethnicity, gender and class are addressed in the genre; the (blurring of) the boundaries between the highbrow and the lowbrow etc. In addition to reading and examining multiple examples of the genre, we will also read materials that will help deepen our understanding of the historical context in which each work was produced, as well as critical theory. The course is taught entirely in Spanish. Expectations include diligent readings, active participation, occasional presentations and discussion leading, two papers, and a final creative project. Prerequisite or permission of Instructor. Prerequisite: 82-345.

This course will cover a broad range of topics, all of which will shed light on how to define the identity of the Hispanic Caribbean, its history and reality, and its cultural expression. Texts for this course will primarily include literary and non-literary pieces (chronicles, historical and political essays, legal treatises, poetry, and song lyrics), and photography, music, art and food. Some of the topics that will be covered through the varied literary, legal, and musical texts are a profile of the Caribbean region, the history of colonization, the institutionalization of race, color and difference, slavery, the sugar plantation and its shaping of regional history and economics, tobacco, sugar and coffee culture, religious syncretism, the urban/rural experience, the Trujillo dictatorship in the Dominican Republic, the Puerto Rican dilemma-territory, statehood or independence, the Cuban revolution, contemporary Hispanic Caribbean and U.S. Latino expressions. Prerequisite permission of the instructor. Prerequisite: 82-345.

This course will focus on contemporary Central America, beginning with an examination of the revolutionary movements and civil wars, but focusing more on the period post 1990, since the signing of the Peace Accords. Through an analysis of the region’s cultural production (literature, documentary film, public art etc.), we will consider a variety of themes relevant to a current understanding of the Central American isthmus, including Human Rights, gender relations, migration, the drug wars, environmental and indigenous rights. This course will familiarize students with some of the central concepts and debates that surround the study of the Central America. The course will be taught in Spanish. Prerequisites: 82-345 or permission of instructor.

Prerequisite: 82-345.

Topics of Japanese Studies
Intermittent: 9 units
FALL 2012: TBA Prerequisite 82-372 or approved equivalent.
Prerequisite: 82-372.

Topics of Japanese Studies
Intermittent: 9 units
FALL 2012 Studies in Latin American Literature and Culture: Comics, historietas y novelas gráficas. Despite often being despised and marginalized by intellectual and educated observers, comics and graphic novels have been steadily informing and transforming the Spanish, Latin American, and Latino mass-media and cultural landscapes for decades. This course offers a survey of some of the most popular comics and graphic novels from the Hispanic/Latino world, and it provides the skills for reading these works critically as cultural artifacts in terms of what they say and how they say it. We will use these texts to investigate Spanish, Latin American, and Latino popular culture, narrative, history, and society; their connections with literary texts, socio-historical and cultural contexts, and economic systems; how issues of race, ethnicity, gender and class are addressed in the genre; the (blurring of) the boundaries between the highbrow and the lowbrow etc. In addition to reading and examining multiple examples of the genre, we will also read materials that will help deepen our understanding of the historical context in which each work was produced, as well as critical theory. The course is taught entirely in Spanish. Expectations include diligent readings, active participation, occasional presentations and discussion leading, two papers, and a final creative project. Prerequisite or permission of Instructor. Prerequisite: 82-345.

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Prerequisite: 82-345.

The Hispanic Caribbean: Rhyme, Reason and Song
Intermittent: 9 units
This course will cover a broad range of topics, all of which will shed light on how to define the identity of the Hispanic Caribbean, its history and reality, and its cultural expression. Texts for this course will primarily include literary and non-literary pieces (chronicles, historical and political essays, legal treatises, poetry, and song lyrics), and photography, music, art and food. Some of the topics that will be covered through the varied literary, legal, and musical texts are a profile of the Caribbean region, the history of colonization, the institutionalization of race, color and difference, slavery, the sugar plantation and its shaping of regional history and economics, tobacco, sugar and coffee culture, religious syncretism, the urban/rural experience, the Trujillo dictatorship in the Dominican Republic, the Puerto Rican dilemma-territory, statehood or independence, the Cuban revolution, contemporary Hispanic Caribbean and U.S. Latino expressions. Prerequisite permission of the instructor. Prerequisite: 82-345.

This course will focus on political drama from Spain. The themes of tyranny, oppression, freedom, and honor will be examined in works by Spanish playwrights such as Miguel de Cervantes, Lope de Vega, Calderón, the Duke of Rivas, Alfonso Sastre, and Antonio Bueno Vallejo. Special attention will be given to the social and historical contexts of the works. Films and critical articles will complement the study of the primary texts. Readings, class discussions, and all assignments will be in Spanish. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisite: 82-345.

This course will cover a broad range of topics, all of which will shed light on how to define the identity of the Hispanic Caribbean, its history and reality, and its cultural expression. Texts for this course will primarily include literary and non-literary pieces (chronicles, historical and political essays, legal treatises, poetry, and song lyrics), and photography, music, art and food. Some of the topics that will be covered through the varied literary, legal, and musical texts are a profile of the Caribbean region, the history of colonization, the institutionalization of race, color and difference, slavery, the sugar plantation and its shaping of regional history and economics, tobacco, sugar and coffee culture, religious syncretism, the urban/rural experience, the Trujillo dictatorship in the Dominican Republic, the Puerto Rican dilemma-territory, statehood or independence, the Cuban revolution, contemporary Hispanic Caribbean and U.S. Latino expressions. Prerequisite permission of the instructor. Prerequisite: 82-345.

This course will focus on political drama from Spain. The themes of tyranny, oppression, freedom, and honor will be examined in works by Spanish playwrights such as Miguel de Cervantes, Lope de Vega, Calderón, the Duke of Rivas, Alfonso Sastre, and Antonio Bueno Vallejo. Special attention will be given to the social and historical contexts of the works. Films and critical articles will complement the study of the primary texts. Readings, class discussions, and all assignments will be in Spanish. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisite: 82-345.
82-476 Japanese Discourse Analysis
Fall: 9 units
Through practical language activities, interviews, and field projects, students will develop refined Japanese discourse analytical skills. The course provides opportunities for students to acquire a high proficiency of communication skills both in the spoken and the written forms focusing on topics such as formal speech, job interviews, and business writing, while increasing exposure to Japanese culture. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as how speaker's perspectives and attitudes are reflected within language expressions. Prerequisite: 82-273 and 82-372.

82-480 Social and Cognitive Aspects of Bilingualism
Intermittent: 9 units
This course introduces students to the nature and extent of bilingualism in individuals and diverse communities in the US and abroad, with an emphasis on the social, historical and political forces that shape the language varieties and abilities of bilinguals. There is also a brief exploration of the psycholinguistic features that characterize bilingual individuals. It also addresses the challenges and opportunities that bilingualism poses for multilingual societies and individuals. Students will develop their knowledge and critical analysis skills of bilingualism through readings, group discussions, field projects and a research paper. Pre-requisites: Students must have completed 82-280, 82-180, 82-384, 82-382 or by permission of the instructor. Prerequisites: 82-180 or 82-280 or 82-382 or 82-384.

82-481 Research Methods in Second Language Acquisition
Spring: 9 units
The course introduces students to research methodology as it applies to language learning and language teaching. It provides an examination of different approaches currently used in Second Language Acquisition (SLA) research ranging from experimental studies to survey investigations. The goal is to develop an ability to critically evaluate, design and implement sound SLA research. Prerequisite: None.

82-483 Topics in Modern Languages
Intermittent
Introduces students to research methodology as it applies to language learning and language teaching. An examination of different approaches currently used in Second Language Acquisition (SLA) research ranging from experimental studies to case studies. The goal is to develop an ability to critically evaluate, design and implement sound SLA research. Prerequisite: None.

82-484 Language Assessment
Spring: 9 units
Theoretical and practical study of aspects of language testing. Purposes and types of language tests are examined in relation to theories of language use and language teaching goals. Testing practices and procedures related to language research and language teaching are also discussed. The course also includes the planning, writing, and administration of tests, and basic test analysis. Prerequisite: None.

82-485 Topics in Modern Languages, Literature and Cultures
All Semesters

82-486 Independent Study in Languages
Intermittent
An opportunity for students who wish to complement their course work at the 400-level and pursue further advanced study. In conjunction with a faculty member, students will arrange a program of study to explore aspects of the target language and culture. Prerequisite: Permission of the Instructor.

82-487 Writing in a Second Language
Intermittent: 9 units
This course will provide students with a comprehensive understanding of second language (L2) writing by surveying fundamental issues and the relations between empirical research, alternative theoretical perspectives, and pedagogical practices in L2 writing. Topics include text, psychological, and social models of L2 writing in instruction. Students are expected to carry out a research project on a focused topic of their choosing concerning L2 writing. Prerequisite or permission of the Instructor. Prerequisites: 82-383 or 82-783.

82-488 Language Learning in a Study Abroad Context
9 units
This course provides opportunities for students to acquire a high proficiency of communication skills both in the spoken and the written forms focusing on topics such as formal speech, job interviews, and business writing, while increasing exposure to Japanese culture. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as how speaker's perspectives and attitudes are reflected within language expressions. Prerequisite: 82-273 and 82-372.

82-489 Service Learning in the Community
Intermittent
This is a community-based research (CBR) course for advanced students who wish to bridge service and action research. 82-489 provides an experiential component that allows students to use their second language and culture skills while acquiring or honing their research skills. CBR helps bridge the gap between university and community life to facilitate the development of life-long learning habits and humanistic citizenship. ML students and faculty will jointly design and execute projects in which to ‘give back’ to the community being studied, which will be chosen based upon the language, culture and/or history of a specific community. Students in this course may participate in historical, ethnographic and cultural research; ethnographic fieldwork; problem solving activities around a particular issue the community is facing; discover how to to best identify a particular linguistic/cultural community and document, interpret, preserve and disseminate its history and culture. Class activities may include group, pair and independent reading and research; group and pair travel; group, pair and one-on-one interaction with community members; public presentations; photography, filming, scanning; webpage and document design; and different kinds of writing. Prerequisite: Completion of all 300-level coursework, or an approved equivalent, or permission of the instructor.

82-491 Literature, Politics and Film in Russia & East Europe Today
Intermittent
This course aims to familiarize the student with the cultural geography of contemporary East Europe, including Russia. Visual texts serve to outline the power politics that have shaped East European and Russian/Soviet cultures from World War II to the present, dramatic day, while verbal texts reveal a range of personal responses to current crises affecting national identity, human rights, gender roles, and the natural environment. While the first of these is the predominant concern of the course, the other three attract a good deal of attention as they take shape in the modes of cultural discourse by which national identities are formulated. The course seeks to sample this discourse mainly in fictional literature and feature film; however, a small number of nonfiction essays and documentary films are seen to demonstrate the breakdown of traditional genres that characterizes intellectual production in times of political flux. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

82-492 The Historical Imagination in Nineteenth-Century Russian Literature
Intermittent
This course aims to familiarize the student with the cultural geography of contemporary East Europe, including Russia. Visual texts serve to outline the power politics that have shaped East European and Russian/Soviet cultures from World War II to the present, dramatic day, while verbal texts reveal a range of personal responses to current crises affecting national identity, human rights, gender roles, and the natural environment. While the first of these is the predominant concern of the course, the other three attract a good deal of attention as they take shape in the modes of cultural discourse by which national identities are formulated. The course seeks to sample this discourse mainly in fictional literature and feature film; however, a small number of nonfiction essays and documentary films are seen to demonstrate the breakdown of traditional genres that characterizes intellectual production in times of political flux. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

82-493 Joseph Brodsky in Context
Intermittent: 9 units
The purpose of the course is to explore the biographical facts, political circumstances and cultural histories underlying the paradoxical and poignant trajectory of Joseph Brodsky’s outstanding achievements as poet, playwright, essayist and spokesman for literature’s value to ethics and education. His work is deeply rooted in the artistic efflorescence of the “Silver Age” in twentieth century Russian poetry, but takes equal inspiration from Brodsky is thus to read Anna Akhmatova, Marina Tsvetaeva and Osip Mandelstam, on the one hand, and John Donne, George Herbert, T.S. Eliot, and W.H. Auden on the other. Works by and about these authors as well as Brodsky thus comprise the reading matter of the course. Poetry, essays and literary criticism are read with a view toward textual explication as a starting point for engaging the larger issues by which any literature subsists. To study the career of this most unusual writer in its bilingual, bicultural context is to confront the most fundamental questions about the meaning by which cultures are empowered and the reasons for which they succeed or fail to coexist in any given place and time. The language of the course is English for all readings, lectures and discussions. No knowledge of Russian is required, but those who can are invited to read in Russian as well. The course follows a predominantly seminar style and writing assignments are required, as is participation in classroom discussion. Prerequisite: None.
82-499 Alternative Break Projec (Language)  
Fall and Spring  
This course provides advanced ML language students and non-ML students enrolled in an Alternative Break student trip project the opportunity to earn credit by engaging in "connected" modes of learning, by identifying and analyzing a problem, and developing plans for short-term and sustainable solutions, reflecting, and creating and disseminating an informational and interpretive website and print materials about their experience. Students will also bring to bear or gain experience in non-academic skillset/interests in areas like photography, image editing, video production, writing, design, website development, sound recording, and art, etc., by doing community service under the auspices of Carnegie Mellon University’s Alternative Break program. Students will earn three (3) units for full participation and fulfillment of course requirements. With the approval of the faculty facilitator, an additional three (3) units may be earned by completing an additional assignment.

82-501 Special Topics: French  
Fall  
Restricted to language majors who wish to go beyond the regular course offerings in French. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-502 Special Topics: French  
Spring  
Restricted to language majors who wish to go beyond the regular course offerings in French. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-505 Undergraduate Internship  
Intermittent  
Approved upper-class language majors may receive credit in connection with work experience related to language learning and language use outside of the classroom setting. As a rule, this experience takes the form of work involving language use or research related to language study at off-campus sites or in the Department. Work or research must be done using the language of study. For off-campus internships, there must be an on-site supervisor appointed to collaborate with the faculty advisor in the final evaluation of the student’s work and progress. The student will be responsible for three written reports evaluating the non-classroom experience with the language of study and several other criteria. Students must obtain prior approval for proposed work. Prerequisite: Permission of target faculty member and the ML internship advisor.

82-506 Hispanic Studies Internship  
Fall and Spring  
Pre-approved, advanced Hispanic Studies majors may receive credit in connection with volunteer or paid work experience (usually in Pittsburgh) in which they primarily or significantly use their target language outside the traditional classroom setting. As a rule, this experience takes the form of work involving language use or research at off-campus sites or in the Department. Work or research must be done using the language of study. For off-campus internships, there must be an on-site supervisor available to collaborate with the faculty advisor in the ongoing and final evaluation of the student’s work and progress. Students will be required to write and submit reflective projects, as determined by the faculty advisor, that evaluate the non-classroom experience in the context of the language and cultural-learning experience and several other criteria that show how the internship connects back to the student’s academic or professional education. Prerequisite: Students must be advanced, Hispanic Studies majors and obtain prior permission for the proposed work from a Hispanic Studies advisor and/or the ML internship advisor.

82-521 Independent Study  
Fall  
Restricted to language majors who wish to go beyond the regular offerings in German. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor and a 400-level course.

82-522 Special Topics: German  
Spring  
Restricted to language majors who wish to go beyond the regular offerings in German. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor and a 400-level course. Prerequisites: 82-427 or 82-428 or 82-429 or 82-430 or 82-431 or 82-435 or 82-436 or 82-437 or 82-438.

82-531 Special Topics Chinese  
3 units

82-532 Special Topics Chinese  
Fall

82-541 Special Topics: Hispanic Studies  
Fall

82-542 Special Topics: Hispanic Studies  
Spring  
Group or individual study in an approved subject area outside of the regular course offerings. Prerequisite: Completion of a 400-level course and permission of an instructor. Restricted to language majors.

82-561 Special Topics: Italian  
Fall  
An option for students who wish to go beyond the regular offerings in Italian. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-562 Special Topics: Italian  
All Semesters  
An option for students who wish to go beyond the regular offerings in Italian. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-571 Special Topics: Japanese  
Fall  
Designed for students of Japanese who wish to go beyond the regular offerings in Japanese. Most suitable for students who have their own ideas for research projects on Japan-related topics of their interest. Students may read Japanese materials (e.g., books, newspapers, magazines, WebPages) and/or speak to native Japanese speakers in Japanese to gather information, and write up findings of their projects in Japanese. Students work on their own projects individually but under the Instructor’s guidance. Prerequisites: Permission of the Instructor.

82-572 Special Topics: Japanese  
Spring  
Designed for students of Japanese who wish to go beyond the regular offerings in Japanese. Most suitable for students who have their own ideas for research projects on Japan-related topics of their interest. Students may read Japanese materials (e.g., books, newspapers, magazines, WebPages) and/or speak to native Japanese speakers in Japanese to gather information, and write up findings of their projects in Japanese. Students work on their own projects individually but under the Instructor’s guidance. Prerequisites: Permission of the Instructor.

82-580 Senior Seminar in Modern Languages  
Spring: 3 units  
This mini-seminar for majors in Modern Languages focuses on general issues in second language learning. It provides an integrative and culminating experience for students as they complete their studies. The course includes consideration of language learning and language maintenance, the role of second languages in American life, issues of linguistic and cultural diversity in the United States today and discussions of multiculturalism throughout the world. The goal of the seminar is for students to reflect upon their language learning experience and to discuss the role that a second language plays in their own lives and in American society today. Co-requisite: Open only to Modern Languages Majors.

82-585 Topics in Second Language Acquisition  
Intermittent: 9 units  
FALL 2012: Section A: Why does language change over time? Why do people speak differently in different situations? How do media and online discourse influence how language evolves from place to place? The study of variation and change in language focuses on the use of quantitative statistical methods to account for phenomena in real-world language data. This course introduces the major questions and methodologies of variationist research in sociolinguistics, computational linguistics, and corpus linguistics. We will learn about the stylistic, social, and linguistic factors that influence how language is produced and perceived. The course will explore how researchers use data drawn from speech, texts, social media, and experimental methods to investigate variation. Students will learn the basic skills needed to analyze corpus and acoustic data, and to perform statistical tests. Students will complete and present an individual research project involving data collection and analysis. Section B: Literacies Across Languages and Cultures: 9 units This course examines differences and similarities in the way literacy is learned and used in diverse languages and cultures. We will first examine the cognitive and social consequences of literacy by analyzing the major characteristics of spoken and written communications. We will then compare literacy practices in a variety of cultural contexts and explore how literacy utilization alters its collective impacts on the users. Finally, through systematic comparisons of literacy education, we will identify the social, cognitive, linguistic factors directly affecting literacy development in different cultural contexts.
57-008 Vocal Master Class I
Fall and Spring
This is a group coaching class for freshmen voice majors.

57-009 Vocal Master Class II
Fall and Spring
This is a group coaching class for sophomore voice majors.

57-100 Convocation
Fall and Spring
A weekly meeting for all music students that features lectures, concerts, and other presentations related to professional development.

57-101 Introduction to Music Technology
Fall and Spring: 6 units
This course gives an overview of music technology through practical information and several hands-on projects. Concepts such as MIDI and digital audio are introduced and specific topics are covered in detail including sequencing, music notation, digital recording, mixing, and production. Throughout the course, students are required to complete several projects and create musical compositions in styles of their own choosing. The student is not graded on the "musicality" of these compositions, but instead on how well they meet the stated project goals by correctly using specific equipment and/or computer programs.

57-102 Finale
Spring: 6 units
This course provides hands-on and in-depth instruction of the Finale music notation program by Coda Music Software. Students will learn how to efficiently use the various notation tools that Finale has to input, edit, and manipulate music. MIDI input, playback, and transcription will also be covered to allow students to quickly notate and hear their music. The goal is to create professional-looking printed scores and parts in a variety of styles from Classical to Contemporary. A basic knowledge of music notation is required.
Prerequisites: 57-101 or 57-171.

57-103 Elective Studio (Beginning Piano Class)
All Semesters: 3 units

57-109 Elective Studio (Guitar Class)
Fall and Spring: 3 units
Using classical and jazz guitar methods, this course is designed to provide a basic set of techniques that will allow students to pursue the avenue of guitar playing that most interests them. While emphasis will be on developing skills in playing the guitar, a basic understanding of the principles of music theory as applied to the guitar will also be acquired. While few students will find it possible to master all of the materials presented, an exposure to the many possibilities of musical expression available on the guitar and an understanding of basic music theory will help to broaden the students' perspective and make future musical experiences, such as listening and performing, more rewarding. Each student is expected to have his/her own instrument. A guitar in good working condition is essential. An acoustic classical or steel string is preferred, an electric with a small battery operated amp is acceptable. Students having no previous training on the guitar will find this class most valuable.

57-110 Elective Studio (Voice Class)
Fall and Spring: 3 units
Students enrolled in group voice will gain an understanding of basic vocal technique and a variety of singing styles. Students will learn about proper breathing, tone production and posture. Vocal styles will include pop, jazz, musical theater and classical. Students will also explore harmonization, improvisation and audition techniques for the singer. This class is geared towards the beginning student.

57-111 Movement and Dance I
Fall: 3 units
The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and execute choreography, movement and staging direction. Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.

57-112 Movement and Dance II
Spring: 3 units
The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and execute choreography, movement and staging direction. Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.
Prerequisite: 57-111.

57-149 Basic Harmony I
Fall: 9 units
This course deals with common-practice harmony. It includes triads and their inversions, tonality and modality, non-harmonic tones, cadences, and the basic concepts of modulation. It includes work on fundamentals for inexperienced students.
Prerequisite: 57-149.
57-151 Counterpoint in Theory and Application
Fall: 6 units
In Counterpoint in Theory and Application, students begin by learning the traditional five species of counterpoint in a tonal context. They then build on this foundation, learning to analyze music in terms of the underlying counterpoint and to apply this analysis to performance, and producing original tonal compositions in two voices.
Prerequisites: 57-150 or 57-153.

57-152 Harmony I
Fall: 9 units
This course deals with common-practice harmony. It includes triads and their inversions, tonality and modality, non-harmonic tones, cadences, and the basic concepts of modulation.

57-153 Harmony II
Spring: 9 units
This course is a continuation of the study of common practice harmony, exploring dissonant and chromatic harmony.
Prerequisite: 57-152.

57-161 Eurhythmics I
Fall: 3 units
Dalcroze Eurhythmics is a unique approach to music learning based on the recognition that meaningful rhythmic movement experience, associated with ear-training and improvisation, reinforces understanding of music concepts, enhances musicianship, and focuses awareness on the physical demands of artistic performance. All concepts are experienced in a musical context. Rhythm reading, notation, analysis, and improvisation are integral to the course. Eurhythmics I covers basic binary and ternary metric units and rhythm patterns in relation to these metric units within simple and compound meters.

57-162 Eurhythmics II
Spring: 3 units
Eurhythmics II introduces combinations of binary and ternary metric units, mixed meters, changing meters, and notation and performance of cross-rhythms.
Prerequisite: 57-161.

57-163 Eurhythmics III
Fall: 3 units
Eurhythmics is a unique approach to music learning developed by the Swiss composer and educator Emile Jaques-Dalcroze (1865-1950). Dalcroze discovered that meaningful rhythmic movement experiences away from their instrument allows students to focus awareness on the physical demands of artistic performance while demonstrating knowledge and understanding of the expressive/interpretive as well as the theoretical aspects of music. Sight reading, conducting, notation, analysis and improvisation are integral to the course. Eurhythmics III Course Content: Divisive vs Additive rhythm, Metric transformation, Irregular subdivisions of metric units, Cross rhythms of 3 against 4, 3 against 5, 4 against 5.
Prerequisite: 57-162.

57-164 Eurhythmics IV
Spring: 3 units
Eurhythmics is a unique approach to music learning developed by the Swiss composer and educator Emile Jaques-Dalcroze (1865-1950). It is a process for awakening, developing and refining innate musicality through rhythmic movement, ear training and improvisation. Through rhythmic movement, students demonstrate knowledge and understanding of the expressive/interpretive as well as the metrical/structural aspects of music. Sight reading, conducting, notation, analysis and improvisation are integral to the course. Eurhythmics IV Course Content: More complex rhythmic problems encountered in composed music, Changing meters and changing metric units within a composition, Rhythm reading of patterns using small note values, Messiaen rhythm techniques.
Prerequisite: 57-163.

57-171 Introduction to Music Technology (self-paced)
Fall and Spring: 6 units
This course gives an overview of music technology through practical information and several hands-on projects. Concepts such as MIDI and digital audio are introduced and specific topics are covered in detail including sequencing, music notation, digital recording, mixing, and production. Throughout the course, students are required to complete several projects and create musical compositions in styles of their own choosing. The student is not graded on the "musicality" of these compositions, but instead on how well they meet the stated project goals by correctly using specific equipment and/or computer programs. This is a self-paced version of 57-101. Material will be covered during weekly class sessions, though students are expected to make time in the evenings or weekends to work on their projects in either the MTC (MM119A) or some other cluster. Students with prior experience may pass out of certain classes and projects by providing teacher with equivalent work (pending teacher approval). In addition to the required projects, there is a final exam which is administered during the last class session.

57-173 Survey of Western Music History
Fall: 9 units
This course surveys the development and contexts of European art music and its global adaptation. While keeping in view the chronology from Gregorian chant to the present, this survey emphasizes key personalities and issues, particularly issues relating to period style and interpretive decisions in performance.

57-180 Basic Solfege I
Fall: 3 units
This course improves the student’s ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the “fixed do” system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes. It includes work on fundamentals for inexperienced students.

57-181 Solfege I
Fall: 3 units
This course improves the student’s ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the “fixed do” system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes.

57-182 Solfege II
Spring: 3 units
Continues 57-181 Solfege I. Prerequisites: 57-180 or 57-181 or 57-185.

57-183 Solfege III
Fall: 3 units
Continues 57-182 Solfege II. Students are given assignments of classical music written in the treble, bass, soprano, alto, and tenor clefs. Writing consists of two-part contrapuntal dictations.
Prerequisite: 57-182.

57-184 Solfege IV
Spring: 3 units
Continues 57-183 Solfege III. Students learn to read atonal music and practice three-part contrapuntal dictations as well as harmonic dictations.
Prerequisite: 57-183.

57-185 Advanced Solfege I
Fall: 3 units
This course improves the student’s ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the “fixed do” system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes. It includes advanced work for experienced students and those with perfect pitch.

57-186 Advanced Solfege II
Spring: 3 units
Continues 57-185 Advanced Solfege I. Prerequisite: 57-185.
This course will focus on the phenomenon of the Beatles. Their songs will be studied, with analysis of the musical and lyrical content and structural elements. What musical styles do the songs address? What were their musical influences? In what ways did their music change over the years? Also, the music’s social context will be studied. Why were the Beatles so popular and influential? What exactly caused Beatlemania? How did the group form, grow, and end? The Beatles are the most famous rock group in history; the reasons for this are as much cultural as musical, and we’ll study the two elements simultaneously. Open to all undergraduate students.

57-211 Movement and Dance III
Fall: 3 units
The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students’ posture and strength. Increase proficiency in dance vocabulary, increase ability to recognize, interpret and execute choreography, movement and staging direction, Enhance kinesthetic awareness and physical confidence and improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout “Movement and Dance I - IV”, courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance. Prerequisite: 57-112.

57-220 English Diction
Fall: 3 units
This one semester course helps singers sing English songs from the Classical and Musical Theater repertoire with clarity, accuracy, ease, uniformity, and expressiveness; to illuminate meaning; and to improve tonal quality through diction.

57-221 Italian Diction
Fall: 3 units
A study of the fundamentals of Italian diction and development of legato vocal style through the analysis of grammatical usage, word construction, vowel colorization, and consonant articulation. Included are in-class performance evaluations, listening assignments, critiques, and private coachings.

57-222 French Diction
Fall: 3 units
This course is designed primarily for singers specializing in French Art Songs of the 19th and 20th centuries. It deals with the use of the International Phonetic Alphabet, its application to singing in French, the use of the liaison and the preparation of the text of a song or aria. One-third of the course is theory and two-thirds of the course is spent on application by performance with piano accompaniment.

57-223 German Diction
Fall: 3 units
In-depth study of German diction - development of legato vocal style in German through the analysis of grammatical usage, word construction, vowel colorization and consonant articulation. Included are in-class German diction evaluations, peer assessment, and emphasis on competency in using the International Phonetic Alphabet.
57-227 Jazz Ensemble
Fall and Spring: 3 units
These are Jazz Ensembles (Section A and Section B) which incorporate a comprehensive approach to Big Band performance and study. The music performed is drawn from all eras of big band repertoire with occasional programs of specific composers and genres. The Jazz Ensembles are carefully coordinated with the Jazz Performance Minor program, the Jazz Vocal Ensemble, and other major ensembles in order to challenge and prepare students for professional music career opportunities. Both ensembles perform on the regular School of Music concert series (2-3 shows per semester) and for on-campus events. Trips to festivals and performances at local venues as part of jazz concert series also occur. The "final exam" for this course is a performance at a local jazz club. Admission of undergraduate and graduate students is by competitive audition and placement is by the director. Grading is based on attendance, preparation, and consistent progress.

57-228 Chamber Music
Fall and Spring: 3 units
Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative. A performance is required each semester.

57-229 Chamber Music
Fall and Spring: 3 units
Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative. A performance is required each semester.

57-230 Baroque Ensemble
Fall and Spring: 3 units
Carnegie Mellon Baroque is a performing ensemble of 15-25 players consisting of winds, strings and keyboard. Students in this ensemble explore the orchestral and chamber music of the 18th Century. The Ensemble performs on modern instruments, incorporating performance practice ideals of the Baroque era. Throughout the rehearsal process, students are encouraged to study original source materials and arrive at historically informed and musically satisfying performances.

57-231 Chamber Ensemble
Intermittent: 3 units
Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative. A performance is required each semester.

57-232 Chamber Music Guitar
Fall and Spring: 3 units
Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative.

57-233 Sonatas
Fall and Spring: 3 units
This course focuses on coaching of performance groups with two members. It parallels Chamber Music, which focuses on coaching of performance groups with three or more members.

57-234 Performance for Composers
Fall: 3 units
This course is for composition majors who choose to fulfill the performance elective requirement in the junior year by completing an independent performance project in the fall semester. Examples of projects can include producing a recital of his/her compositions, or pursuing other performing interests, such as writing music for a School of Drama production. Registration by composition faculty permission only.

57-236 Performance for Composers
Spring: 3 units
This course is for composition majors who choose to fulfill the performance elective requirement in the junior year by completing an independent performance project in the spring semester. Examples of projects can include producing a recital of his/her compositions, or pursuing other performing interests, such as writing music for a School of Drama production. Registration by composition faculty permission only. Prerequisite: 57-234.
57-283 Music History I  
Fall: 9 units  
This course will be a historic overview of each period of Western European art music and in-depth analysis of representative musical genres and forms. The first semester will begin with the birth of Opera and the Baroque era and continue through the early works of Beethoven. We will then analyze the genres/forms of the Middle Ages and Renaissance.  
Prerequisite: 57-173  
Corequisite: 57-289.

57-284 Music History II  
Spring: 9 units  
This course will be a historic overview of each period of Western European art music and in-depth analysis of representative musical genres and forms. The second semester will begin with the middle period works of Beethoven and will continue chronologically through the major composers, styles, and forms of the 19th and 20th centuries.  
Prerequisite: 57-173  
Corequisite: 57-290.

57-285 Music History III  
Spring: 9 units

57-289 Repertoire and Listening for Musicians II  
Fall: 3 units  
This is a continuation of the School of Music’s four-semester listening curriculum. Students listen critically to essential music which has stood the test of time and to superior performances. This semester’s repertoire includes units focusing on contrapuntal masterpieces from the Middle Ages through 20th Century, and further builds score-reading experience. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. Midterm and final listening tests. Proficiency requirement for sophomore music majors. Other students admitted with instructor’s permission. Repertoire and Listening for Musicians I and II are not prerequisites.

57-290 Repertoire and Listening for Musicians III  
Spring: 3 units  
This is the culmination of the School of Music’s four-semester listening curriculum. Students listen critically to essential music which has stood the test of time and to superior performances. Highlights of this semester’s repertoire include units on Middle and Late Beethoven as well as a decade-by-decade survey of the 20th Century. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. Midterm and final listening tests. Proficiency requirement for sophomore music majors. Other students admitted with instructor’s permission. Repertoire and Listening for Musicians I-III are not prerequisites.

57-293 Keyboard Studies Test (Degree)  
Fall and Spring  
This is the keyboard proficiency test which is a requirement for all undergraduate music majors who are not piano majors.

57-294 Beginning Piano Test  
Fall and Spring  
This is the keyboard proficiency test which is a requirement for all music performance, music composition, music technology, and music theory minors.

57-300 Bagpipe and Drum Band  
Fall and Spring: 3 units  
The Pipe Band at Carnegie Mellon is a competitive Grade 3 band in the Eastern United States Pipe Band Association. The band competes at various Scottish festivals and Highland Games during the school year. The band also performs at university activities throughout the year. These include Convocation, Homecoming, Spring Carnival, and Commencement. Other engagements are Spring Concert at CMU and the St. Patrick’s Day Parade in Pittsburgh. The band has also played as an opening act for the Pittsburgh Sydney Symphony, the Pittsburgh Steelers and a Rod Stewart concert.

57-301 Bagpipe History  
Intermittent: 3 units  
This course covers all types of bagpipe music, including Ceol Mor and Ceol Beag, and studies the prominent composers from MacCrimmon to the present day. Students compose their own material in all time signatures commonly used. The course covers Piobaireachd, Marches, Strathspeys, Reels, Hornpipes, and jigs, as well as harmony and the ability to write out tunes from repetitive listening.

57-302 Bagpipe Construction  
Intermittent: 3 units  
This course is an in-depth study of Piobaireachd construction, including Primary, Secondary, Tertiary Types A & B, Supplementary Types A & B, and Irregular. The course covers the different patterns in Light Music construction. Students also study the makeup of Pipe Band Medleys and repertoire for competition versus concert.  
Prerequisite: 57-307.

57-303 Bagpipe Literature and Repertoire  
Intermittent: 3 units  
This course will cover the origins of the bagpipe and Piobaireachd, bagpipe music in competition, military, and dance. We will also cover major piping competitions, famous bagpipe players, and piping today.

57-304 Bagpipe Maintenance  
Intermittent: 3 units  
All aspects of bagpipe maintenance are covered in this course, from basic hemping and tying in bags to reeds set-up and manipulation. The course includes study of all types of reeds, cane and synthetic, as well as drone and chanter, and recognition of pipemakers’ patterns and distinctive hallmarks.

57-305 Bagpipe Reedmaking  
Intermittent: 3 units  
This is a hands-on course where the student learns how to make pipe chanter reeds by the traditional method of gouging, shaping, and tying up. This course follows 57-304, Bagpipe Maintenance. Further analysis of chanter and drone reeds will be covered also.  
Prerequisite: 57-304.

57-306 World Music  
Fall: 6 units  
An exploration of the diversity and complexity of music from around the world. The class will have three sections: 1. Classical music from India, Iran, Indonesia, and Asia; 2. Native and folk music from Africa, Europe, Australia, and the Americas; 3. The influence of world music on Western classical music. This class will include some reading, listening to CDs, watching videos, and papers and/or presentations. If time permits, there will be special musical activities and invited guests.  
Prerequisite: 57-173.

57-307 Bagpipe Theory  
Intermittent: 3 units  
This course prepares students for 57-302, Bagpipe Construction. All aspects of Bagpipe Theory are covered, including time signatures, grand staff, musical rudiments, musical terms and definitions, and writing of simple tunes from memory.

57-308 Bagpipe Advanced History  
Intermittent: 3 units  
This course is an in-depth study of the origins of the bagpipe, including the oral tradition, the Hereditary pipers and their teachings, piping in the military, prominent teachers, and a study of the Tree of Piping dating from MacCrimmon to the present day.

57-310 Bagpipe Advanced Literature and Repertoire  
Intermittent: 3 units  
This course prepares students who have covered all other courses for the Graduate Exam from the Institute of Piping in Scotland. It covers all aspects of theory, history, and practical ability. An in-depth paper should also be prepared by the students in this course on a piping topic of their choice.

57-313 Topics in Movement and Dance  
Fall: 1.5 units  
This intermediate level mini-semester course furthers the dance foundation practiced in the first two years of the School of Music movement curriculum. This modern dance technique class will explore momentum based phrase material, body alignment and release, movement dynamics, inversions and floor work. This course focuses on the information and the tools needed to extend movement technique, skills, and performance quality.  
Prerequisite: 57-212.

57-314 Topics in Movement and Dance  
Fall: 1.5 units  
This intermediate level mini-semester course furthers the dance foundation practiced in the first two years of the School of Music movement curriculum. This ballet technique class is designed to increase flexibility, strength, balance and articulation through the execution of classical ballet vocabulary and alignment to enhance strength and fluidity in performance.  
Prerequisite: 57-212.
57-315 Topics in Movement and Dance  
Spring: 3 units  
This intermediate level course furthers the dance foundation practiced in the first two years of the School of Music movement curriculum. Classes will encourage an understanding of dance through the practice of creative improvisation and composition. The course is designed to develop the process of exploration and creation of movement and its performance applications.  
Prerequisite: 57-212.

57-329 Beginning Piano for Minors  
Fall and Spring: 3 units  
This is a small group lesson for music performance, music composition, music technology, and music theory minors who cannot pass the required beginning piano test.

57-330 Beginning Piano for Minors  
Spring: 3 units  
This is a small group lesson for music performance, music composition, music technology, and music theory minors who cannot pass the required beginning piano test.

57-331 Principles of Education  
Fall: 9 units  
This course introduces students to the art and science of being an educator. Content includes views of the academic and social structure of the school, physiological & social characteristics of learners that influence instruction, widely recognized research on learning & teaching, and appropriate & effective class preparation and teaching strategies.  
Corequisite: 57-608.

57-332 Introduction to Conducting  
Fall: 6 units  
This course develops the basic skills needed to conduct instrumental ensembles or a small orchestra. It is primarily focused on conducting technique, body language and body coordination and communication. It also deals with learning and translating an instrumental or orchestral score into actual music. The goal is to achieve a clear and communicative technique upon which an artistic interpretation can be built. The student works periodically with a pianist or a small chamber ensemble.

57-333 Band and Choral Arranging  
Spring: 6 units  
This course presents basic techniques of arranging music for elementary and secondary school choral and instrumental ensembles. Instruments and voices are reviewed for best scoring properties and systematic aural & visual score analyses of repertoire are used to reveal various approaches to scoring ensemble sound.  
Prerequisite: 57-153.

57-334 Fundamentals of Marching Band  
Fall: 3 units  
A marching band, due to its visibility and high degree of student involvement, is an integral part of secondary school music programs. The well-schooled music education graduate must have knowledge of this unique form of music performance. This course, designed primarily for those seeking a career in teaching, will accommodate students with no experience and others who have participated in marching band. Among the many areas of concentration will be: philosophy, show charting, marching fundamentals and commands, logistical awareness, and budget formulation. Observation of and active assistance with Carnegie Mellon Kiltie Band will be part of the course content.

57-336 Instrumental/Choral Conducting  
Spring: 6 units  
This course is a continuation of Introduction to Conducting. The course offers a more detailed conducting technique, adding those subjects related to choral conducting. This is followed by the study and the analysis of interpretation from the point of view of the conductor and ends stressing a set of important practical items, including the psychological attitude and the leadership a conductor must develop as well as the organization and achievement of a fruitful rehearsal technique. The students work periodically with a pianist, a soloist or a chamber ensemble on traditional works and on their own compositions in the case of composition majors.  
Prerequisite: 57-332.

57-337 Sound Recording  
Fall and Spring: 6 units  
This course centers around the recording studio in the School of Music: how the studio works, and how to record various types of music, including classical music, using the studio and Kresge Recital Hall, which has audio and video links to the recording studio. The method of instruction is to learn by doing, and the goal, from the very first session, is to achieve professional-sounding results. Equipment includes a complete 24-track ProTools system, professionally designed control room that can accommodate up to 24 people, outboard preamps and other gear, and an interesting array of microphones. All recording is direct to hard disc.

57-338 Sound Editing and Mastering  
Fall and Spring: 6 units  
The raw recording is just the first step in the process of creating a professional finished audio product. "Editing" is the art of piecing together different takes to make one final 'good take.' "Mastering" is the art of polishing the 'good take' to perfection—balancing all the instruments and tracks, adding special effects, setting final levels. If 'recording' seems like an high-energy activity—involving engineers, musicians, producers—"editing and mastering" are the necessary counterparts—long tedious hours of solitary confinement honing the skills of the mastering engineer. Those taking this course are expected to have significant music skills: actively playing a musical instrument (or composition), and/or the ability to read a piano score at the least, and a full orchestra score from any recent century, including our own, at the most. Class attendance is essential; work outside of class is necessary.  
Prerequisite: 57-337.

57-339 Acting III  
Fall: 6 units  
This course will build upon the foundation laid in the first year, with a more concentrated look at scene work, an audition workshop that focuses on cold readings as well as monologues, and a character-development project that works to identify specific issues that inhibit freedom on stage. More in-depth work on songs and arias will lead into a musical scene project. This semester will close with a classical text project in which the students will work with verse.  
Prerequisite: 57-241.

57-340 Acting IV  
Spring: 6 units  
Continues 57-339 Acting III.  
Prerequisite: 57-339.

57-347 Electronic and Computer Music  
Fall: 6 units  
This course builds on the concepts learned in Introduction to Music Technology (57-101) and gives added knowledge in the areas of composition using digital and analog devices as well as various computer programs. Building computer models of both analog and digital synthesizers as well as drum machines, loop players and various other sound processing effects will be covered in detail. Students will be required to produce several projects throughout the course demonstrating their understanding of various concepts in electronic music. More emphasis is placed on the overall quality of the end musical product than in 57-101 in order to prepare students for music production in a professional setting.  
Prerequisites: 57-101 or 57-171.

57-349 Supervised Theory Teaching  
Fall and Spring: 6 units  
This course provides teaching skills in theory for students who have already completed the theory class and will assist the professor by correcting homework, delivering a short lecture, developing a class syllabus and tutoring individual students. The work is done under direct supervision and advice from the regular professor who is always present in the class. Enrollment limited to a maximum of two students per class.

57-350 Dalcroze Piano Improvisation  
Fall and Spring  
These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.

57-351 Dalcroze Piano Improvisation  
Fall and Spring  
These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.  
Prerequisite: 57-350.
This music education course develops basic woodwind playing and teaching in order to insure a good foundation for a beginning student. Also covered are the various woodwind instruments and their techniques. Much time is devoted to proper stance, grip, and stroke in order to prepare students for their future teaching. Students spend most of their time learning the basic concepts of beginning band and orchestra techniques. This class gives the non-percussion major a background in the fundamentals of music reading independence in young players.

57-355 Secondary Guided Teaching
Spring: 3 units
This course enables students to apply instructional strategies in local secondary school music classes. School visits provide opportunities to work with band, choral, & orchestral ensembles and general music classes. Seminar discussions with the cooperating teachers familiarize students with both school-wide and classroom management issues that affect teaching, learning, motivation, and the administration of music programs. Prerequisites: 57-332 and 57-335 and 57-356 and 57-360 and 57-361 and 57-362 and 57-363 and 57-375 and 57-380 and 57-381 and Corequisite: 57-376.

57-356 Elementary Guided Teaching
Fall: 3 units
This is the second level of field experience in the public schools. This course provides for observation and closely supervised teaching experiences with elementary age children in a school setting. Corequisite: 57-375.

57-359 Career Strategies for Musicians
Intermittent: 3 units
This course will assist students in developing the necessary expertise and materials to transition successfully from music student to professional musician. Four major areas will be covered: 1.) The multifaceted activities of today's professional musicians, individual assessments to determine strengths and challenges related to these activities, and strategies for addressing challenging areas; 2.) Developing promotional materials for entrepreneurial and salaried opportunities. Entrepreneurial materials include business cards, letterhead, photo, bio, performance resume, email list, press release, flyers, grant proposals, demo CD and website. Salaried materials include an employment resume and cover letter; 3.) Self-employment considerations, including budgeting, taxes, health insurance, and unions; and, 4.) Communications, including handling auditions, introducing pieces, introducing group members, and pitching ideas. You must have the talent, determination, and work ethic to succeed. Now learn the marketing, business and communications skills to close the gap.

57-360 Brass Methods
Fall: 3 units
This music education course develops basic brass playing and teaching techniques for beginning and intermediate instrument classes. The course includes training in beginning band program design,aural & visual diagnosis of individual and ensemble playing problems, and methods of accelerating music reading independence in young players.

57-361 Percussion Methods
Fall: 3 units
This class gives the non-percussion major a background in the fundamentals of teaching percussion. The main focus of the course is snare drum. The students spend most of their time learning the basic concepts of beginning snare drum so they will be prepared to teach beginning students of any grade level. Much time is devoted to proper stance, grip, and stroke in order to insure a good foundation for a beginning student. Also covered are the various mallet instruments, timpani, and all small hand percussion. Students will learn about purchasing proper equipment for the various levels of learning in common school programs.

57-362 Woodwind Methods
Spring: 3 units
This music education course develops basic woodwind playing and teaching techniques for beginning and intermediate instrument classes. The course includes training in beginning band program design,aural & visual diagnosis of individual and ensemble playing problems, and methods of accelerating music reading independence in young players.

57-363 String Methods
Spring: 3 units
String Methods prepares music educators for work in the public schools. A major portion of class time will be applied to violin and cello techniques. Upon completion of the course, the student will be expected to demonstrate the technical skills of a second year beginning string student. Students will also be introduced to various method books, string supplies, and repairs.

57-364 Conducting Practicum
Fall and Spring: 3 units
This course provides applied conducting experience for the conducting minor.

57-370 Stage Direction
Spring: 3 units
This course provides an internship working with a middle or high school music theater production. Students may participate in coaching, direction, and choreography. In addition, they keep a journal of their experience and submit a final paper describing what they have learned from working with the teachers or professional directors who were responsible for the production. It is suggested that this course be taken during the spring semester when most music theater productions are scheduled.

57-374 Music in the Urban School
Fall and Spring: 9 units
This course will involve workshops with nationally known instructors in eurhythmics, world drumming, contemporary popular music, and classroom management. The course will require attendance at workshops, classroom observations and closely supervised teaching experiences. Schools involved are all inner city schools with a poverty level of 75% or above. This course is offered as the result of a grant received from the Federal Department of Education by the School of Music, the Pittsburgh Public Schools, and the Wilkinsburg School District. Prerequisite: 57-331 Corequisite: 57-356.

57-375 Music in the Elementary School
Fall: 6 units
This course is designed to provide a philosophical background for teaching music in the elementary school and to provide a variety of pedagogical techniques, which are essential when teaching music from Preschool through Grade 6. Prerequisite: 57-331 Corequisite: 57-356.

57-376 Music in the Secondary School
Spring: 6 units
This course covers a variety of topics related to the development and the management music programs in secondary schools. Emphasis is placed on the leadership, classroom management, general music & performance course content, and routine administrative planning. Prerequisite: 57-331 Corequisite: 57-355.

57-377 Psychology of Music
Intermittent: 9 units
Music cognition is an interdisciplinary approach to understanding the mental processes that support musical behaviors, including perception, comprehension, memory, attention, and performance. Like language, music is a uniquely human capacity that arguably played a central role in the origins of human cognition. This course is survey of current approaches to and theories about the perception and cognition of music. Topics covered include psychoacoustics; the cognitive neuroscience of music; relationships between music and language; the nature of musical knowledge; and debates about aesthetics, evolutionary psychology, and musical universals. At the end of this course a student should be able to identify key theories and hypotheses in music cognition as they relate to memory, emotion, physiology, neurology, acoustics, language, and evolution. They will be able to comparatively evaluate hypotheses and place them in an intellectual context. These objectives will be achieved through critical reading, discussions, and written exercises. There are no prerequisites for this course. It will be helpful for you to know some basic elements of music theory (such as the names for chords, Roman numerals, and so on), but some extra help will be available to cover these topics. Some notational basics will be covered in the first lecture.

57-381 Collaborative Piano I
Fall and Spring
This is the first in a series of hands-on courses which allow the student to accumulate experience accompanying in a professional venue. Students will be assigned to a vocal and/or instrumental studio and will have the opportunity to coach repertoire with a professional accompanist. Assignments may include playing for instrumental juries.
Prerequisite: 57-151.

57-382 Collaborative Piano II
Fall and Spring
Continues 57-381 Accompanying I.
Prerequisite: 57-381.

57-383 Collaborative Piano III
Fall and Spring
Continues 57-382 Accompanying II.
Prerequisite: 57-382.

57-384 Collaborative Piano IV
Fall and Spring
Continues 57-383 Accompanying III.
Prerequisite: 57-383.

57-385 Collaborative Piano V
Fall and Spring
Continues 57-384 Accompanying IV.
Prerequisite: 57-384.

57-386 Collaborative Piano VI
Fall and Spring
Continues 57-385 Accompanying V.
Prerequisite: 57-385.

57-391 Keyboard Studies (Music Ed)
Fall and Spring: 3 units
This course develops piano skills necessary for work in the elementary and secondary schools. Special emphasis is placed on transposition, score reading, harmonization and sight-reading. This course is required for all music education majors.
Prerequisite: 57-292.

57-392 Keyboard Studies (Music Ed)
Fall and Spring: 3 units
Continues 57-391 Keyboard Studies V. This course is required for all music education majors.
Prerequisite: 57-391.

57-393 Keyboard Studies Test (Music Ed)
Fall and Spring
This is the keyboard proficiency test which is a requirement for all undergraduate music majors who are music education minors.

57-399 Music-Cinema-Culture
Intermittent: 9 units
The first 100 years of the 20th Century’s only original art form, whose advent has brought about tremendous social and cultural changes. Students view selected films, learning first the basics of film theory, cinema’s working structures and the function of music. Ultimately, they are able to analyze, in the form of a written essay, the function and value of the music in a particular film and the impact such music has had on society.

57-408 Form and Analysis
Spring: 6 units
This course provides a working understanding of all styles and genres of Western classical and contemporary repertoire. Students will explore various aspects of the compositional process, from basic organizational structures to the details of individual musical phrases. They will learn to see and to hear the most important compositional features of a piece of music and will develop a deeper understanding of the music they perform, conduct, and compose.
Prerequisite: 57-151.

57-412 Opera Since Wagner
Intermittent: 9 units
In the 400-year arc of opera history, the last 125 years have seen the genre’s apogee, perigee, and current renaissance. Between the Wagnermania of the late nineteenth century and today’s vogue for both opera and “popera,” new opera production slowed greatly in the third quarter of the last century as composers rejected its traditions and audiences turned increasingly to rock and pop. In this course, we will survey this trajectory by viewing and analyzing eight repertory staples: Wagner – Parsifal, Debussy – Pelléas et Mélisande, Puccini – Turandot, Berg – Wozzeck, Gershwin – Porgy and Bess, Britten – Peter Grimes, Messiaen – Saint François d’Assise, Reich – Three Trolls. We will also become acquainted with other works related to these staples, from Strauss to Saariaho and Tan Dun, and ask numerous questions. What can these operas’ characters and techniques tell us about late modern subjectivity? What happened to the great national traditions? In what musical styles has opera flourished and languished? How have audiences changed? How has the magic of opera itself changed, from the nature of its heroes and heroines to its performance forces and media? The goals of this course are to 1) promote intimate knowledge of the eight core operas; 2) encourage familiarity with numerous related opera plots, opera composers, and twentieth- and twenty-first-century musical styles; 3) broaden literary and musical analytical tools to include historical, aesthetic, and (multi)cultural perspectives on opera; and 4) improve oral and written communication skills about opera. Requirements: Attendance at opera screenings, readings, quizzes, small written assignments, and a 17- to 20-page research paper on an opera of your choice written since 1850. Required text: Mervyn Cook, ed. The Cambridge Companion to Twentieth-Century Opera (2005).
Prerequisite: 57-284.

57-413 The Interpretation of Music
Intermittent: 6 units
What does it mean to “interpret” music? How does performance differ from interpretation? How do we distinguish a good interpretation from a bad one? To answer these questions, this course examines Metaphor, History, Influence, Meaning, Analysis, Performance, Musicology, and other concepts, applying them to works like the Mendelssohn Violin Concerto, Chopin’s Fantasie Impromptu, Beethoven’s “Ghost” Trio, and Debussy’s “Voiles.” Our readings draw mainly from Lawrence Kramer’s Interpreting Music (2011). Our goal is to appreciate the complexity and nuance inherent in the process of music making and to formulate our individual values in the interpretation of music.

57-414 Music and Nature
Intermittent: 9 units
Musicians and philosophers have long explored the rapport between music and nature, tracing music’s origins alternatively to nature and human culture and defining nature differently according to their time and place. This course will examine the opposition between nature and culture through both musical compositions and philosophical writings. We will study theories of the origin of music (from Lucretius to bioluminescence), theories of music that seek justification by appealing to nature (from Boethius to Gregorian chant), and theories that question whether natural sounds can be music. We will also examine musical representations of place, weather, and animals through the perspectives of ecocriticism and notions of the pastoral. Repertory will include Vivaldi’s “Spring” Concerto, Beethoven’s “Pastoral” Symphony, Wagner’s Ring of the Nibelung, Mahler’s Symphony No. 3, and Debussy’s La Mer. We will compare landscapes by Sibelius and Copland, birds by Dvorak, Bartok, Ravel, Stravinsky, and Messiaen, and whales by Crumb and Havhaness. We will also treat statements on the environmental crisis by composers Harrison Birtwistle, Philip Glass, Peter Sculthorpe, and John Luther Adams. Required texts: Lawrence Kramer’s Interpreting Music (2011). Our readings draw mainly from Lawrence Kramer’s Interpreting Music (2011). Our goal is to appreciate the complexity and nuance inherent in the process of music making and to formulate our individual values in the interpretation of music.

57-415 Mozart Operas
Intermittent: 3 units
In the genre with the highest stakes and the highest failure rate, Mozart composed the earliest operas to have staked a permanent place at the center of the repertory. This course seeks to account for his success, to explain why he succeeded where others failed and what has made his operas beloved for over 225 years. We begin with a brief overview of all of Mozart’s operas and discuss the types of opera in circulation in late 18th- and early 19th-century Austro-Hungary, especially opera seria, opera buffa, and Singspiel, and the pressures that shaped the music and libretto of each production. In addition, we will examine the types of operas in circulation in late 18th-century Austro-Hungary, especially opera seria, opera buffa, and Singspiel, and the pressures that shaped the music and libretto of each production, from the type of patronage to the style of recitative. Then we examine The Marriage of Figaro, Don Giovanni, and The Magic Flute at a pace of about one act per class session, looking at poetry, dramaturgy, stagecraft, acting, performance practice, character development, theme, and politics, always through the filter of Mozart’s music, especially its melody, reform elements, blurring of genre and affect, vocal counterpoint, use of topics, and musical symbolism.
57-417 Major Choral Ensemble
Fall and Spring: 6 units
There are two choral ensembles. Concert Choir is a select ensemble of approximately 40 voices of superior vocal/musical talent and experience in the choral idiom. Performance requirements are more stringent than those of the Repertory Chorus. Repertory Chorus is an ensemble of undetermined size. Emphasis is placed on vocal technique and development, musical skills in the rehearsal with minimum performance requirements. Audition required.

57-418 Major Instrumental Ensemble
Fall and Spring: 6 units
There are two instrumental ensembles: Orchestra and Wind Ensemble. Rotating seating plans, within and between ensembles, will prevail at the discretion of the Director of Orchestral Studies and the Director of the Wind Ensemble. The instrumental faculty will be consulted. All music majors who are required to enroll in an instrumental ensemble must audition for placement and enroll in Major Instrumental Ensemble. Audition required.

57-420 Jazz Vocal Ensemble
Fall and Spring: 3 units
A highly selective group of mixed voices who perform contemporary jazz and pop vocal arrangements. Open to all CMU students. Audition required.

57-423 Repertoire Orchestra
Fall and Spring: 3 units
This course thoroughly acquaints participants with the standard works one would expect to encounter as part of a career as an orchestral player. Assigned repertoire will be read each class session. All students are eligible to register for this course by special permission. Students who are not placed in the Carnegie Mellon Philharmonic are given priority for registration.

57-424 Percussion Ensemble
Fall and Spring: 3 units
This ensemble is open to all percussion majors.

57-428 Theatre Orchestra
Intermittent
Instrumental ensemble which accompanies vocal productions in the School of Music or the School of Drama.

57-429 Beginning Piano for Children
Fall and Spring: 6 units
This course is the first of two courses in a year-long internship in the piano teaching of young children, combining class and private instruction: a study of the basic teaching/learning process as applied to piano teaching, covering comprehensive step-by-step presentation in reading, rhythm, ear training, sight reading, technique, and musicianship. Under supervision, students will teach the weekly group class and private lessons. Weekly conferences will be held for learning the presentation of materials for class teaching, analyzing pedagogical problems, and developing communication skills with both young pupils and their parents.
Prerequisite: 57-273.

57-430 Music of Iran
Intermittent: 9 units
The Iranian civilization is one of the oldest continuing civilizations in the world. Music has played an important role in the continuation and preservation of this ancient culture. In this course, the traditional, folk, and contemporary music of Iran will be studied and discussed. The focal point of the course will be the Persian modal system, the Dastgah. Starting with a historical survey of the ancient and medieval Persian music, different aspects of the Dastgah system will be demonstrated and discussed. In addition, religious music and folk music of Iran as well as Iranian contemporary music will be discussed during the course.

57-431 Italian Literature and Repertoire
Spring: 3 units
The course provides a bibliography of repertoire in the Italian language. Material will include art songs and cantatas and will be presented via individual student performances in class, listening to recordings and group survey of repertoire. Reading and writing assignments will serve to establish historical perspective as well as programming considerations.

57-432 French Literature and Repertoire
Spring: 3 units
This course examines French songs for solo voice. Representative works from 18th through 20th centuries will be studied in the context of music history, style and programmatic considerations. Classes consist of individual performance, listening to recordings, and group survey of repertoire. Reading and written assignments establish historical perspective as well as programming considerations.

57-433 Musical Theatre Literature and Repertoire
Fall: 3 units
This class covers music theatre repertoire for two semesters, beginning chronologically with the operetta and concluding with current theatre composers. Each student will be assigned songs to prepare from these musicals. These songs can also be used for music theatre auditions. Students are expected to research all assigned songs and perform them in the proper style. Notebooks must be kept which include all lecture notes, class song assignments and music for songs performed individually.

57-434 Musical Theatre Literature and Repertoire
Spring: 3 units
Continues 57-433 Musical Theatre Literature and Repertoire.
Prerequisite: 57-433.

57-435 German Literature and Repertoire
Spring: 3 units
The course examines German repertoire composed for solo voice. Representative works from the Baroque period through the 20th Century are studied in the context of musical style, vocal demands and programmatic considerations. Repertoire focuses on art songs and cantatas, but also includes certain oratorio excerpts, which are included frequently in recital programs. A bibliography of German repertoire is compiled through individual or group performance of songs, listening to recordings and through research assignments, the latter of which focuses upon the works of specific composers. Reading assignments are included to establish an historical perspective.

57-436 English/Contemporary Literature and Repertoire
Spring: 3 units
This course provides a bibliography of repertoire in the English language. Material will be limited to art songs and will be presented via individual student or group performances in class, and recorded performances. Research assignments will be required for selected anthologies or for works by specific composers. Repertoire will be examined according to vocal requirements, musical style, and programmatic function. The repertoire will consist primarily of works by British and American composers, but works by Russian and Spanish composers will also be included.

57-437 Literature and Repertoire
Fall and Spring: 3 units
This course deals with literature and repertoire for orchestral instruments. There are multiple sections organized by instrument categories or specific instruments.

57-438 Multitrack Recording
Fall and Spring: 3 units
This course builds upon the ideas learned in Sound Recording (57-337), but with an emphasis on close microphone techniques and popular music styles. Students will work in small groups and complete at least two recording projects. $10.00 materials fee.
Prerequisites: 57-337 or 57-341.

57-441 Analysis of 19th Century Music
Intermittent: 9 units
This course will provide students with a variety of tools for the analysis of music from Schubert to Mahler and early Schoenberg. The primary emphases will be on small-scale (chord-to-chord) harmonic organization, on the larger-scale organization of tonal centers, and on form, but other issues will also be explored (e.g. rhythm and meter, text/music relations). The course will sample a wide range of repertoires, including solo piano music, orchestral music, and opera, and it will have a special emphasis on chamber music including the German Lied.
57-442 Analytical Techniques
Fall: 6 units
Analytical Techniques is an upper level music support course for juniors and seniors who have completed the undergraduate required music theory curriculum in harmony and counterpoint. Studying the principles of Piston, Forte, Schenker and other important music theorists, students will learn to use whatever analytical techniques are best suited to better understand each individual piece. The primary goal of the course is to develop independent skills in analyzing their own repertoire as performers, conductors, composers, and teachers. Prerequisite: 57-408.

57-444 Principles of Counterpoint
Intermittent: 9 units
This course explores the development of Western music composed with multiple independent parts. The first half of the course traces the history of part-writing from medieval organum to the twenty-first century. Emphasis is given to study of pre-Baroque and twentieth-century music, and to the conceptual shifts that occurred moving in and out of the common-practice period. The second half of the course examines, across multiple musical styles, specific contrapuntal techniques such as imitation and ground bass forms. Assignments include both writing exercises and analysis, culminating in a term project on a topic selected by the student.

57-456 Eurhythmics Applications for Performing and Teaching
Fall: 6 units
Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. For musicians, meaningful rhythmic movement reinforces understanding of music concepts while focusing awareness on the physical demands of artistic performance. This approach to musical problem solving is applicable also to studio and classroom teaching. Prerequisite: 57-164.

57-448 Brass Pedagogy
Fall: 3 units
In this course we introduce the “Art of Teaching”. In this case, to teach, develop and encourage young brass players just starting an instrument or who are in their early stages of development. Concepts of basic brass pedagogy will involve the following topics: •: Music as Metaphor •: Teaching young students •: Listening •: Developing a Concept of Sound •: Posture •: Breathing •: Embouchure •: Articulation: Single Tonguing, Multiple Tonguing •: Mouthpiece playing •: The Warm-up •: Slurring •: Intonation •: The Upper Register •: Endurance •: Vibrato •: Dental Braces •: Orchestral Playing •: Performance Preparation •: Taking Auditions Brass students will leave CMU with a basic understanding of the pedagogical needs and requirements of beginning and inexperienced students, so that they may begin private teaching studio upon graduation.

57-449 Beginning Piano for Children
Fall and Spring: 6 units
This course is the second of two courses in a year-long internship in the piano teaching of young children, combining class and private instruction: a study of the basic teaching/learning process as applied to piano teaching, covering comprehensive step-by-step presentation in reading, rhythm, ear training, sight reading, technique, and musicianship. Under supervision, students will teach the weekly group class and private lessons. Weekly conferences will be held for learning the presentation of materials for class teaching, analyzing pedagogical problems, and developing communication skills with both young pupils and their parents. Prerequisite: 57-429.

57-459 Score Reading/Keyboard Harmony
Spring: 6 units
This course is for pianists, organists, and other musicians with good keyboard skills. It is a practical, hands-on learning experience, Students learn by doing and observing other students. All work is done at the keyboard. Prerequisites: 57-153 or 57-156 or 57-408.

57-463 Eurhythmics for Non-Majors
Fall: 6 units
Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. This class is for juniors and seniors only.

57-464 Eurhythmics Applications for Non-Majors
Fall: 6 units
Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. This class is for juniors and seniors only.

57-465 Eurhythmics Applications for Performing and Teaching
Fall: 6 units
Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. For musicians, meaningful rhythmic movement reinforces understanding of music concepts while focusing awareness on the physical demands of artistic performance. This approach to musical problem solving is applicable also to studio and classroom teaching. Prerequisite: 57-164.

57-466 Eurhythmics Applications for Performing and Teaching
Fall: 6 units
Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. For musicians, meaningful rhythmic movement reinforces understanding of music concepts while focusing awareness on the physical demands of artistic performance. This approach to musical problem solving is applicable also to studio and classroom teaching. Prerequisite: 57-164.

57-469 Production: Scenes
Fall: 6 units
Preparation of operatic and musical theatre scenes with a public performance of the scenes at the end of the semester. Specific repertoire based upon the proficiency of the individual student. Prerequisites: 57-212 and 57-340.

57-470 Production: Scenes
Spring: 6 units
Preparation of operatic and musical theatre scenes with a public performance of the scenes at the end of the semester. Specific repertoire based upon the proficiency of the individual student. Prerequisites: 57-212 and 57-340.

57-471 Production: Performance
Fall: 6 units
Preparation of an operatic or musical theatre production with a fully staged public performance of the production at the end of the class. Prerequisites: 57-212 and 57-340.

57-472 Production: Performance
Spring: 6 units
Preparation of an operatic or musical theatre production with a fully staged public performance of the production at the end of the class. Prerequisites: 57-212 and 57-340.

57-477 Music of the Spirit
Intermittent: 6 units
This is a guided listening course which surveys musical explorations of spirituality. While the majority of repertoire will be from the Western Classical tradition, musics of a variety of cultures will be included. The music will be organized by particular religious traditions and by universal themes, such as community, death/afterlife, birth/new birth, martyrs/heroes, transcendence/immanence, meditation/contemplation/trance, etc. Most course materials, including streaming audio, are online, with one meeting per week in the classroom. Will include participatory introductions to numerous forms of chant. Requires oral and written reports.

57-478 Survey of Historical Recording
Intermittent: 6 units
Through an intensive listening regimen, illustrated virtual lectures, discussion, and projects, this online course introduces major performing artists and highlights major developments in music media. The emphasis is on classical recordings. But there will also be excursions into influential and iconic popular artists.

57-480 History of Black American Music
Fall: 6 units
Come and explore the rich musical heritage of Black America. This course will survey the music of Black America beginning with the African legacy and continuing through the music of the Twentieth Century. Class sessions will involve discussions, listening, viewing of films, and reports by students on topics of individual interest. Discussions will involve, historical, cultural and political perspective, as well as the music and composers themselves. Lecturing will be at a minimum. Innovative testing in quiz show format will be used. No prerequisites required. Open to upper level undergraduate students.
A one hour private lesson per week for all music majors.

Fall and Spring: 9 units

57-487 Advanced Solfege III
Fall: 3 units
Covers the same concepts as Solfege IV in more challenging material, from Bach chorales in open score to excerpts by Bartok, Honegger, Stockhausen, or Boulez. Dictations are three-part contrapuntal and difficult harmonic three and four parts.
Prerequisite: 57-186.

57-488 Advanced Solfege IV
Spring: 3 units
Continues 57-487 Advanced Solfege III.
Prerequisite: 57-487.

57-496 Minor Studio
Fall and Spring
A 45-minute private lesson per week for all music performance minors.
There is a fee for the lessons.

57-497 Minor Studio
Fall and Spring
A 45-minute private lesson per week for all music performance minors.
There is a fee for the lessons.

57-498 Minor Studio
Fall and Spring
A 45-minute private lesson per week for all music performance minors.
There is a fee for the lessons.

57-499 Minor Studio
Fall and Spring
A 45-minute private lesson per week for all music performance minors.
There is a fee for the lessons.

57-500 Major Studio (Voice)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-501 Major Studio (Piano)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-502 Major Studio (Organ)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-503 Major Studio (Harp)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-504 Major Studio (Violin)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-505 Major Studio (Viola)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-506 Major Studio (Cello)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-507 Major Studio (Double Bass)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-508 Major Studio (Guitar)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-509 Major Studio (Flute)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-510 Major Studio (Oboe)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-511 Major Studio (Clarinet)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-512 Major Studio (Clarinet)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-513 Major Studio (Bassoon)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-514 Major Studio (Clarinet)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-515 Major Studio (Horn)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-516 Major Studio (Trumpet)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-517 Major Studio (Trombone)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-518 Major Studio (Euphonium/Baritone)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-519 Major Studio (Tuba)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-520 Major Studio (Percussion)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-521 Major Studio (Composition)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-522 Major Studio (Bagpipe)
Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-570 Music and Technology Seminar
1 unit

57-597 Senior Project
Fall and Spring
A composition for orchestra required of all senior composition majors.

57-598 Junior Recital
Fall and Spring
A half recital required of all junior performance majors.

57-599 Senior Recital
Fall and Spring
A full recital required of all senior performance majors.

57-603 Practice Teaching (Elementary)
Fall and Spring
Experience in working with elementary students in a public school setting. The teaching is supervised by an experienced public school teacher and members of the CMU music education faculty.
Prerequisites: 57-355 and 57-393.

57-604 Practice Teaching (Secondary)
Fall and Spring
Experience in working with secondary students in a public school setting. The teaching is supervised by an experienced public school teacher and members of the CMU music education faculty. Students may choose a vocal or instrumental emphasis in the secondary placement.
Prerequisites: 57-355 and 57-393.

57-607 Vocal Methods
Spring: 3 units
This course enables each student to develop a pleasant, healthy, and musically expressive voice and to develop effective vocal pedagogy.

57-608 Observation
Fall: 3 units
This music education offering is an independent study course designed to introduce students to a range of instructional practices used by elementary and secondary strategies that impact learning, student motivation, classroom management, and accommodations for special learners.
Corequisite: 57-331.
57-610 Internship
Fall and Spring
A student can receive credit for an unpaid internship in a music related field. The amount of credit is determined by the number of internship hours.

57-611 Independent Study in History
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-612 Independent Study in Theory
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-613 Independent Study in Research
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-614 Independent Study in Performance
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-615 Independent Study in Electronic and Computer Music
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-616 Independent Study in Literature and Repertoire
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-617 Independent Study in Sound Recording
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-618 Independent Study in Conducting
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-619 Independent Study in Opera
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-620 Independent Study in Solfege
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-621 Independent Study in Eurhythmics
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-622 Independent Study for Competitions
Fall and Spring: 3 units
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-623 Independent Study in Diction
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-624 Independent Study in Theater Composition
Fall and Spring
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-641 Dalcroze Research Paper
Fall: 3 units
Candidates in the Dalcroze Certification Program are required to submit a research paper based on their understanding of Dalcroze principles based on their experience and supported by appropriate literature.

57-642 Dalcroze Research Paper
Spring: 3 units
Candidates in the Dalcroze Certification Program are required to submit a research paper based on their understanding of Dalcroze principles based on their experience and supported by appropriate literature.

57-691 Dalcroze Pedagogy/Practice Teaching
Fall
This first semester of a two semester course focuses on Dalcroze pedagogy and supervised practice teaching with preschool and elementary school age children.

57-692 Dalcroze Pedagogy/Practice Teaching
Spring
This second semester of a two semester course focuses on applications of Dalcroze pedagogy and practice teaching with upper elementary and middle school age students.

Naval Science - ROTC Courses

32-100 Naval Laboratory
Spring: 3 units
Military drill, physical fitness, and leadership seminars.

32-101 Introduction to Naval Science
Spring: 6 units
A general introduction to the naval profession and to concepts of Seapower. Instruction emphasizes the mission, organization, and warfare components of the Navy and Marine Corps. Included is an overview of officer and enlisted ranks and rates, training and education, and career patterns. The course also covers naval courtesy and customs, military justice, leadership, and nomenclature. This course exposes the student to the professional competencies required to become a naval officer.

32-102 Seapower and Maritime Affairs
Spring: 6 units
This course surveys US naval history from its European origins to the present with emphasis on major developments and the geopolitical forces shaping these developments. Also included is discussion of the theories and writings of naval historian and strategist Alfred Thayer Mahan. The course will finish by covering present day concerns in seapower and maritime affairs including the economic and political issues of merchant marine commerce, the law of the sea, the navy and merchant marine of the former Soviet Union (FSU), and a comparison of US and FSU maritime strategies to include the rise and decline of the Soviet Navy.

32-200 Naval Laboratory
Spring: 3 units
Military drill, physical fitness, and leadership seminars.
32-201 Leadership & Management
Fall: 9 units
This course is a comprehensive advanced-level study of organizational behavior and management. Topics include a survey of the management functions of planning, organizing, and controlling; an introduction to individual and group behavior in organizations; an extensive study of motivation and leadership. Major behavioral theories are explored in detail. Practical applications are explored by the use of experiential exercises, case studies, and laboratory discussions. Other topics developed include decision-making, communication, responsibility, authority and accountability.

32-202 Naval Ships Systems I
Spring: 9 units
A detailed study of ship characteristics and types including ship design, hydrodynamic forces, stability, compartmentalization, propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. Included are basic concepts of the theory and design of steam, gas turbine, internal combustion, and nuclear propulsion. Shipboard safety and firefighting are also discussed.

32-212 Navigation
Spring: 9 units
An in-depth study of piloting and an introduction to celestial navigation theory. Students learn piloting skills including the use of charts, visual and electronic aids, and the theory and operation of magnetic and gyro compasses. Students develop practical skills in both piloting and celestial navigation. Other topics include tides, currents effects of wind and weather, plotting, use of navigation instruments, types and characteristics of electronic navigation systems, and the typical day’s work in navigation. Also included is a study of the international and inland rules of the nautical road, relative motion, vector analysis theory, and relative motion problems.

32-300 Naval Laboratory
Spring: 3 units
Military drill, physical fitness, and leadership seminars.

32-302 Navigation and Naval Operations II
Spring: 9 units
A study of the international and inland rules of the nautical road, relative motion, vector analysis theory, relative motion problems, formation tactics, and ship employment. Also included is an introduction to naval operations and shipboard evolutions, vessel behavior and characteristics in maneuvering, applied aspects of ship handling, and afloat communications.

32-310 Evolution Of Warfare
Spring: 9 units
This course is to provide the student with a very basic understanding of the art and concepts of warfare from the beginning of recorded history to the present day. The intent of the curriculum is to familiarize the student with an understanding of the threads of continuity and the interrelations of political, strategic, operational, tactical, and technical levels of war from the past, while bringing into focus the application of these same principles and concepts to the battlefields of today and the future.

32-311 Naval Ship Systems I-Engineering
Fall: 9 units
A detailed study of ship characteristics and types including ship design, hydrodynamic forces, stability, compartmentalization, propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. Included are basic concepts of the theory and design of steam, gas turbine, internal combustion, and nuclear propulsion. Shipboard safety and firefighting are also discussed.

32-312 Naval Ship Systems II-Weapons
Spring: 9 units
This course outlines the theory and employment of weapons systems. The student explores the processes of detection, evaluation, threat analysis, weapon selection, delivery, guidance and explosives. Fire control systems and major weapon types are discussed, including capabilities and limitations. The physical aspects of radar and underwater sound are described in detail. The facets of command, control, and communications are explored as a means of weapons system integration.

32-400 Naval Laboratory
Spring: 3 units
Military drill, physical fitness, and leadership seminars.

32-401 Naval Ships Systems II
Fall: 9 units
This course outlines the theory and employment of weapons systems. The student explores the processes of detection, evaluation, threat analysis, weapon selection, delivery, guidance and explosives. Fire control systems and major weapon types are discussed, including capabilities and limitations. The physical aspects of radar and underwater sound are described in detail. The facets of command, control, and communications are explored as a means of weapons system integration.

32-402 Leadership and Ethics
Spring: 6 units
The study of naval junior officer responsibilities. The course exposes the student to a study of ethics, decision making and responsibility as well as counseling methods, military justice administration, naval human resources management, directives and correspondence, naval personnel administration, material management and maintenance and supply systems. This capstone course in the NROTC curriculum builds on and integrates the professional competencies developed in prior course work and professional training.

32-410 Amphibious Warfare
Fall and Spring: 9 units
A historical survey of the development of amphibious doctrine and the conduct of amphibious operations. Emphasis is placed on the evolution of amphibious warfare in the twentieth century, especially during World War II. Focus is applied to four main themes: political/strategic situation, sea-to-land transitions, tactics ashore, and development of amphibious technology. Present day potential and limitations on amphibious operations, including the rapid deployment force concept, are explored.

32-411 Naval Operations and Seamanship
Fall: 9 units
Designed as an introduction to naval operations and shipboard evolutions, vessel behavior and characteristics in maneuvering, applied aspects of ship handling, and afloat communications. This course builds upon the information presented in Navigation 32-212, Engineering 32-311, and Weapons Systems 32-312. An understanding of the nautical rules of the road, relative motion and vector analysis are utilized in discussion regarding the conduct of naval operation to include formation tactics and ship employment. The student will also be introduced to the various components of naval warfare and their role in sea control and power projection missions within naval and joint operations.

Philosophy Courses

80-100 Introduction to Philosophy
All Semesters: 9 units
In this introductory course we will explore three major areas of Philosophy: Ethics, Metaphysics, and Epistemology. Accordingly the course is divided into three sections. In each section we will read primary sources and discuss some of the main philosophic problems associated with that area. These will include: moral problems (Ethics), problems arising in the debates about free-will, personal identity or intelligence (Metaphysics), and inquiries about the scope and limits of human knowledge (Epistemology). We will then introduce some theories designed to solve such problems, and try to understand the strengths and weaknesses of these theories. We will apply different techniques and theories to issues that we might encounter in the real world. We will use class discussions, homeworks and papers to learn skills for evaluating arguments. These skills include: how to present a philosophic argument, what are the assumptions that justify it, what are its weaknesses and its strengths, whether such weaknesses can be resolved and, if they cannot be resolved, why.

80-101 Freshman Seminar: Mathematical Context
Fall: 9 units
This course explores historical, scientific, and philosophical contexts in which mathematics is developed, and the ways in which mathematics enables us to obtain precise descriptions of various aspects of human experience. Topics include the development of non-Euclidean geometry and Riemann’s theories of manifolds with applications in cosmology, and the theory of computability and applications in cognitive psychology. Students will become familiar with fundamental set theoretic notions, as well as Turing machines and cellular automata.

80-102 Honors Program in Introduction to Philosophy
Fall and Spring: 3 units
This three credits extension of 80-100 is open to Freshmen and Sophomores by invitation of their instructor only. The seminar meetings examine interesting puzzles and open controversies concerning topics raised in 80-100.
80-110 Nature of Mathematical Reasoning
Fall: 9 units
This course focuses on understanding mathematical reasoning, not on mastering a particular mathematical theory like linear algebra or calculus. It explores instances of mathematical reasoning and rigorous argumentation, with examples from the history of science and mathematics. We consider the "Let's Make a Deal" puzzle, the counter-intuitive results of HIV testing, and how to assess the relative size of infinite sets, all problems which defy intuitive solution but which look simple after they are put in mathematical form. The course is designed for students at the freshman and sophomore levels who are not interested in a mathematically intense major.

80-130 Introduction to Ethics
Fall: 9 units
This course provides both a historic and thematic survey of western ethical theory. Key figures such as Aristotle, Hobbes, Kant, Mill, and Nietzsche will be presented as background to the thematic problems of relativism, egoism, and other concepts in ethical theory. Students will take part in the creative process of developing skills necessary to engage in reflective moral reasoning. This process will culminate in the use of interactive multimedia modules simulating real-world scenarios involving difficult moral choices. Participating in a class ethics committee will provide students with opportunities for personal reflection on the ways moral reasoning can be used to expand our understanding of hard choices and moral dilemmas.

80-135 Introduction to Political Philosophy
Spring: 9 units
As an introductory course, we will seek to trace out the historical and philosophical dimensions of the polis from its origins in Ancient Greece to its current manifestation in present-day society. Special emphasis will be placed on the concept of "democracy." The readings and lectures will focus on the history and concept of democracy (as an idea and as an institution); the basic concepts and problems of political philosophy (e.g., liberal and libertarian ideas of justice); and applied political philosophy (e.g., regional initiatives in deliberative democracy).

80-136 Social Structure, Public Policy & Ethics
Spring: 9 units
The course will consider ethical questions that arise regarding social structure and public policy's impact on both people and the environment. It will consider the role of political institutions (and, sometimes, individuals) in dealing with some of the greatest challenges facing our generation: World poverty, environmental problems, and globalization. Some of the questions we will consider include: Are developing countries obligated to ameliorate poverty by providing foreign aid, are they obligated to prevent environmental problems, and is globalization and free trade in particular a good idea? The course uses theory, case studies, and empirical evidence to consider these questions from a few different moral and political perspectives. We will extract some economic principles and rational dilemmas from examining these issues and pay attention to how legal and empirical considerations interact with ethical considerations.

80-150 Nature of Reason
Fall: 9 units
This course offers an intellectual history of philosophical views regarding the nature of human reasoning in mathematics and the sciences, from ancient to modern times. The first part of the course traces the search for deductive methods for obtaining certain knowledge, starting with Aristotle and Euclid, and continuing through the Middle Ages and late Renaissance thought, to the work of Boole and Frege in the nineteenth century. The second part of the course considers the history of skepticism about empirical knowledge, covering Plato, Sextus Empiricus, Descartes, Pascal, and Hume, along with replies to skepticism in the works of Bayes and Kant. The third part of the course discusses theories of the nature of mind, culminating in the computational conception of mind that underlies contemporary cognitive science.

80-180 Nature of Language
Fall and Spring: 9 units
Language is used to talk about the world or to describe it, but how do we go about describing language itself? Linguistics is the name given to the science of language, whose task it is to give such a description. The discipline of linguistics has developed novel tools for describing and analyzing language over the last two hundred years and in this course we learn what these tools are and practice applying them. Sub-areas of linguistics which we study include phonetics (the study of speech sounds), phonology (the study of sound systems), morphology (the study of parts of words), and syntax (the study of combinations of words). Beyond this, we look at changes in language over time, and we consider the puzzle of linguistic meaning. The methods of linguistics are useful in the study of particular languages and in the study of language generally, so this course is useful for students of foreign languages as well as those interested in going on to study language acquisition, psycholinguistics, sociolinguistics, philosophy of language, and computer modeling of language.

80-195 Research Training
Fall and Spring: 9 units
This course is part of a set of 100-level courses offered by H&S departments as independent studies for students in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college major requirement, although the units do count toward graduation as elective units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&S Academic Advising Center. For H&S students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative GPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

80-201 Epistemology
Fall: 9 units
Epistemology, one of the cornerstones of philosophy since ancient times, concerns the relationships between belief, truth, and knowledge. This course will explore fundamental issues in epistemology, such as the analysis of the concept of knowledge, epistemic justification and scientific method, a priori knowledge, theories of truth, skepticism, reliabilism, and coherentism. Both classic texts and contemporary journal articles will be discussed. There are no prerequisites, but students with some philosophical sophistication and/or formal ability will be more comfortable with the material.

80-208 Critical Thinking
Intermittent: 9 units
This course is an introduction to practical reasoning. The course will contain an elementary introduction to concepts important for reasoning and decision making, such as validity, probability, and utilities. Students will extensively practice critically analyzing and evaluating a wide variety of arguments found in newspapers, magazines, and elementary accounts of scientific reasoning. In order to help students develop the skills to analyze and evaluate arguments, the course will introduce several software packages recently developed at CMU that help students diagram arguments and causal reasoning; these packages have been shown to improve students critical reasoning skills. In addition, students will learn about a wide variety of statistical, logical, psychological, and causal fallacies that are used to mislead people.

80-210 Logic and Proofs
All Semesters: 9 units
This web-based course introduces students to central issues in logic and develops their ability for constructing and refuting arguments. It addresses the question: How can one analyze the structure of rational discourse or, more specifically, the logical structure of argumentation? An answer to this question requires: (i) uncovering the logical form of statements; (ii) defining the correctness of logical steps; (iii) formulating inference rules for the logical forms; (iv) designing strategies for argumentation with the inference rules. The course takes these steps for both sentential and quantificalional logic. Presentation: The material is presented on-line, through some exercises must be done with pen and paper. Additional reading of historical and philosophical character complements the systematic on-line presentation. Weekly small discussion meetings with collaborative reviews, substantive discussions and critical reflections supplement the on-line material.
80-211 Logic and Mathematical Inquiry  
Intermittent: 9 units  
Since ancient times, those searching for truth have looked to mathematical arguments as a paradigm of rational inquiry. We study the structure of such arguments and their application. In the first half of the course, we develop the syntax and semantics of sentential and quantificational logic while in the second, we apply this logic to examine the axiomatic method in set theory and introduce formal models of computation. This course prepares students to take the 310-311 series on the fundamental (in)completeness and (un)decidability theorems of modern logic.

80-212 Arguments and Logical Analysis  
Summer: 9 units  
Are there rational methods that can further our knowledge? The notion of rational inquiry presupposes that there are appropriate methods for the pursuit of knowledge. In this course, we will investigate the means by which a successful argument justifies its conclusion, as well as various subtle ways in which other arguments fail. In the course of our inquiry, we will take a historically informed approach to studying logic and argumentative fallacies. We will also discover that these tools are useful for constructing and analyzing arguments in all disciplines from philosophy and history to psychology and physics. Our primary goal is to learn to use these tools to make our thinking and writing clearer, more precise, and more critical. To that end, our coursework will consist in homework and exams on topics in logic, as well as essays on a wide variety of topics. This course is intended for students from any discipline who would like to improve their writing and critical thinking skills.

80-220 Philosophy of Science  
Intermittent: 9 units  
In this course, we will examine some historical case studies (e.g., the Copernican revolution in astronomy) against which we will assess views pertaining to the significance, justification, and production of scientific knowledge. For example, should scientific theories be understood literally or as computational devices for deriving new predictions? How can universal conclusions ever be justified by a finite data set? Does explanation contribute to a theory’s confirmation by the evidence? Does science aim to find the truth? Is probability in the world or only in our minds? Is explanation a matter of finding causes or are causes whatever it is that explains? Is scientific rationality objective or culture-relative?

80-221 Philosophy of Social Science  
Intermittent: 9 units  
Can the behavior of societies be studied using the methods of natural science? This course takes a critical-historical approach to the question, which reveals that there have been interactions between natural science and the study of societies in both directions. Hobbes approached the study of man and society in the 17th century using the newer methods of natural science of the time, and his analysis is the foundation for many approaches in the social sciences today. Rousseau’s work raised a question about the order of explanation: does the behavior of societies arise from the nature of man, or is the nature of man formed by society? We then examine the development of methods for the social sciences which were later imported into the natural sciences: the statistics of populations. With this historical background as a backdrop, we consider more contemporary views of philosophers of sociology and the social sciences and methods employed in the social sciences. This course provides a philosophical background to more formal courses in the social sciences and more advanced courses in philosophy of the social sciences. It also serves as an overview to anyone interested in the topic.

80-223 Philosophy of Economics  
Intermittent: 9 units  
Can the behavior of societies be studied using the methods of natural science? This course takes a critical-historical approach to the question, which reveals that there have been interactions between natural science and the study of societies in both directions. Hobbes approached the study of man and society in the 17th century using the newer methods of natural science of the time, and his analysis is the foundation for many approaches in the social sciences today. Rousseau’s work raised a question about the order of explanation: does the behavior of societies arise from the nature of man, or is the nature of man formed by society? We then examine the development of methods for the social sciences which were later imported into the natural sciences: the statistics of populations. With this historical background as a backdrop, we consider more contemporary views of philosophers of sociology and the social sciences and methods employed in the social sciences. This course provides a philosophical background to more formal courses in the social sciences and more advanced courses in philosophy of the social sciences. It also serves as an overview to anyone interested in the topic.

80-226 Revolutions in Science  
Fall: 9 units  
Contemporary science emerged in the 17th century from a series of dramatic innovations in theory and method that has come to be called the Scientific Revolution. Since then, science has been punctuated by repeated ‘revolutions’ in which scientists have been forced to select among dramatically different frameworks for explaining the world: is the Earth or the sun at the center of the solar system? Do kinds of organisms develop from other kinds, or is each created independently? Is matter infinitely divisible or are all things made of atoms in a void? The way scientists choose one framework over another can tell us something about the nature of science. In this course, we will focus on episodes of scientific change to gain insight into a range of questions: Is scientific change governed by a single method or does each new revolution involve the invention of a new scientific method? How do scientists argue for the existence of unobservable processes, properties, or objects like atoms? In what way do these arguments differ from those of their ancient predecessors? What makes them compelling? We’ll begin our investigation by examining the overthrow of ancient Greek astronomy and physics by Galileo, Kepler, and Newton. We will then turn to a number of subsequent revolutions in other areas of science such as chemistry, geology, and evolutionary biology. Students will work with original texts by Galileo, Newton, Darwin, and others.

80-230 Ethical Theory  
Spring: 9 units  
Every day, even in very subtle ways, we make judgments of value that shape our lives and our conduct. This course will examine four influential attempts at providing a systematic account of the source and nature of moral value, its relationship to other kinds of value, and the practical implications of different answers to these questions. This focus on the fundamental structure of moral value will frequently engage topics such as the nature of the good, subjectivist and objectivist accounts of value, forms of moral naturalism verses attempts at moral constructivism, and will draw on historical as well as more contemporary sources. Particular attention will be paid to articulating the specific sources of disagreement that distinguish competing moral theories in order to facilitate our ability to adjudicate between them on a reasoned basis.

80-235 Political Philosophy  
Fall: 9 units  
At the heart of political philosophy lie fundamental questions such as: What constitutes a just society? How, and under what circumstances do individuals incur special political obligations to a particular state? What are the limits of the legitimate authority of the state and how are they defined? This course provides a systematic investigation of the way such questions are answered by dominant schools of liberal political theory, such as the social contract tradition, utilitarianism and libertarianism. Because the liberal political tradition is also strongly egalitarian in nature, the course will examine different conceptions of political equality and conflicting views about the respects in which community members may have a just claim to equal treatment. Readings are drawn from classic works by authors such as Hobbes, Locke, Kant, and Mill, and from the works of contemporary theorists like Rawls, Nozick and others.

80-241 Ethical Judgments in Professional Life  
Fall: 9 units  
This is a multimedia, hybrid course that examines the numerous ethical issues, problems and dilemmas that confront professionals in such areas as medicine, law, engineering, the media, government and the natural and social sciences. As a hybrid course, it includes educational materials in video streaming format, an audio CD, an electronic discussion board and web-based “guided inquiries” that students navigate and complete. Topics discussed include: Responsibility in the professions, obligations to clients, conflicts of interest, whistleblowing, codes of ethics and ethics in engineering, medicine, law, media, computer science and business among others. This course meets one day a week and employs a case study discussion format during class.

80-243 Business Ethics  
Intermittent: 6 units  
Various moral mazes that confront managers in the contemporary business organization will be the focus of this course. Topics treated will include: conflicts of interest, whistleblowing, confidentiality and privacy, environmental issues, sexual harassment, diversity in the workplace, international business ethics and corporate social responsibility. Codes of business ethics, ethics audits, recommendations from the U.S. Sentencing Guidelines Commission, the Sarbanes-Oxley Act, ethics hotlines, business ethics officers, corporate ethics committees and other mechanisms designed to address the ethics of business will also be examined.
80-244 Environmental Ethics
Intermittent: 9 units
The aim of the course is to provide students with an introduction to environmental ethics. One aspect of environmental ethics is the study of values underlying human relations to the natural environment. In particular, we are interested in issues that arise when these values conflict. This course begins with a discussion of our current environmental crises, and different approaches to solving these crises. Many of these solutions, however, depend on particular kinds of knowledge, particularly scientific knowledge, about our environment. Thus, another important aspect of environmental ethics is determining what we do, and what we can, know. To address these issues, we will explore some problems in philosophy of science, with special emphasis on the various eco-sciences.

80-245 Medical Ethics
Spring: 9 units
This course provides an introduction to core ethical issues in health care, medical research, and public policy. Topics include: the moral responsibilities of health care providers to patients and various third parties such as the government or insurance companies, the status of health as a social good, and questions of individual liberty and social responsibility at the ends of life including issues such as abortion, physician assisted suicide, and the definition of death. We will also examine specific ethical issues in the conduct of medical research and look at the impact of technological innovation on our notions of health, disease, life, death, and the family. If time permits, we may also discuss issues related to genetics and cloning. While the course engages such substantive ethical issues it also attempts to sharpen students’ skills in practical reasoning through argument analysis, analogical reasoning, and the application of theory and principles to particular cases.

80-247 Ethics and Global Economics
Fall: 9 units
The course considers the secret lives of every day things — like food, water, and oil. It suggests that it is by understanding these things that we can best address some of the greatest challenges facing our generation including world poverty and environmental problems. After a short introduction to arguments and ethical theory, the course considers how basic commodities like oil, water, and bananas have shaped and will continue to shape human and natural history. The course then outlines some of the environmental and social implications of the ways we create, use, and trade basic commodities. Finally, it considers prospects for dealing with some of the challenges posed by our past, present, and future use of these commodities. Global Economics and Ethics lays the groundwork for dealing with some of the most important issues facing our generation.

80-250 Ancient Philosophy
Intermittent: 9 units
This course will cover Ancient Greek philosophy from the pre-Socratics to the later Hellenistic writers. We will prepare the background for Socrates and Plato by tracing the various historical and intellectual movements that led up to and through the flourishing and downfall of Hellenism. A study of Socrates (as represented in Aristophanes’ comedy and Plato’s early dialogues) will lead to an in-depth reading of Plato’s Gorgias, Symposium and sections of the Republic. We will approach Aristotle through his ‘practical philosophy’ presented in the Nicomachean Ethics. The final sections will discuss the Epicurean, Skeptic, and Stoic movements as well as the work of Cicero. Excerpts from other works of Plato and Aristotle as well as Martha Nussbaum’s recent work on Aristotle and Hellenistic philosophy will accompany selected parts of the course.

80-251 Modern Philosophy
Intermittent: 9 units
Descartes’ project to doubt all received knowledge and begin from scratch marked the beginning of an intellectual upheaval, helping to launch what is now called the Modern period of philosophical thought; the Western world is today the heir of modernism. Locke, Leibniz, Hume, and Kant are several of the most important figures of this period. We will examine works of these thinkers, exploring both the new sorts of questions that these philosophers raised and their new methods of doing philosophy, which together mark a fundamental break with the traditions that preceded them. We will devote special attention to the new theories of knowledge the philosophers developed. By the philosophical revolution of the 17th and 18th centuries occurred during a time of great scientific progress and political upheaval in Europe; as part of our course we will consider the relation of certain of these developments to the new questions and methods of the modern philosophers.

80-253 Continental Philosophy
Intermittent: 9 units
This course provides students with an overview of key historical and philosophical movements in European Philosophy. The cultural and historical background for 20th Century Continental Philosophy covers Descartes, Kant, Kierkegaard, and Nietzsche (Heidegger and Marx are also options). Early to mid-20th Century Continental Philosophy covers the central tenets of phenomenology and existentialism (e.g., Intentionality, Being-in-the-World, Bad Faith). This part will involve selections from the works of, for example, Husserl, Heidegger, Sartre and Merleau-Ponty. Finally, cultural and philosophical trends such as Structuralism, Hermeneutics and Post-modernism (e.g., Derrida, Foucault, Lyotard and Habermas) will be addressed.

80-255 Pragmatism
Intermittent: 9 units
American Pragmatism represents an energetic attempt to bridge the divergent cultures of science and the humanities. The movement’s founder, C.S. Peirce, was trained in chemistry and worked as a physicist, but he was also deeply concerned with the contemporary philosophical portrayal of science, which distinguished sharply between theoretical knowledge and practice. Peirce responded by constructing a comprehensive philosophy emphasizing the scientific importance of community, fallibility, and action. Pragmatism was also developed and vigorously popularized by William James, who aspired to be a painter and ended up as an acknowledged founder of modern empirical psychology. James extended Peirce’s position by defending the role of values in even the purest of empirical sciences. John Dewey, who is also well-known for his role in education, interpreted science as an evolving social system and developed a theory of aesthetics based on what we now call the psychology of problem solving. The pragmatists made and continue to make lasting contributions to modern statistics, logic, and social science and their emphasis on community, fallibility, action, and value in science are still of primary importance in philosophy and in the ongoing dialogue between the scientific and humanistic cultures.

80-256 Modern Moral Philosophy
Intermittent: 9 units
This course will address some of the central aesthetic theories concerning the nature of our judgments of the beautiful and of the sublime that were developed around the 18th century. The famous divide between the British empiricist philosophers and the rationalist philosophers of the Continent regarding the sources of human knowledge, was paralleled in a dispute regarding the nature of aesthetic judgments. In this course we will study the aesthetic theories of some of the most important figures of this period, with an emphasis on the work of Immanuel Kant.

80-257 Nietzsche
Intermittent: 9 units
During his life in the late 19th-century, Friedrich Nietzsche was a relatively obscure German philosopher. Since his death, however, he has become deeply influential and well-known, and was a source of inspiration for many important 20th-century thinkers. Despite his popularity, Nietzsche’s philosophy remains relatively mysterious, and often misunderstood. Much of his writing consisted of aphorisms, rather than more traditional prose and arguments, and many of his positions seem to contradict one another. This course will cover a broad range of Nietzsche’s writings, focusing on such central concepts as the will to power, eternal recurrence, and the oft-misunderstood Ubermensch (“overman”). Throughout, we will focus on developing a consistent interpretation of an enigmatic philosopher whose views have been miscalculated and misappropriated throughout the past century.
80-261 Empiricism and Rationalism
Intermittent: 9 units
A central issue in Western philosophy has been whether reason or experience (or some of both?) lies at the foundation of human knowledge, and the 17th and 18th centuries are a defining period of European history because they contribute the basic model of science and the ideals of intellectual and political enlightenment that are still dominant today. Specifically, we will focus on the problems encountered in trying to give an adequate account of the nature of the external world, the structure of our minds, and the nature and limitations of knowledge in the thought of Descartes, Locke, Leibniz, Berkeley, and Hume. The course has two main goals: (1) to study the metaphysical and epistemological theories of selected philosophers, paying close attention to the arguments offered on behalf of very strange positions, and (2) to help you improve your analytical and critical skills, including, for example, extracting and evaluating philosophical arguments.

80-264 William James and Philosophical Psychology
Fall: 9 units
This course will be devoted to the reading and discussion of William James’ “Principles of Psychology,” including its relevance to foundational questions about current research. Though first published in 1891, the foundational issues addressed in this landmark work have not lost their relevance; it is often said that this work set the agendas for much of the research subsequently carried out in psychology. This course should appeal to anyone interested in philosophy of mind, philosophy of psychology, and philosophy of science.

80-270 Philosophy of Mind
Intermittent: 9 units
The mind poses one of the greatest challenges in our attempts to understand how the world works. In this course, we will explore a variety of fascinating topics that pose these challenges. We shall ask about how the mind relates to the material world, whether a definition of the mind or its various features can be given, whether having a mind makes a difference on the world. More specific topics will concern the relation between minds and computing, the nature of consciousness, what difference there is between thinking and perceiving (when do we perceive, how many forms of perception are there), and whether we can ever be wrong about our minds (e.g. can we ever be wrong that we are in pain?). We shall also focus on a variety of interesting phenomena and pathologies including split brain patients, bodily illusions, and schizophrenia.

80-275 Metaphysics
Intermittent: 9 units
The topical agenda of this course will vary. Typical topics include the problem of personal identity, the nature of human freedom, the nature of the self, the nature of reality and being, the nature of causality, and the question of whether solutions to such problems can be given. Classical as well as contemporary philosophic texts will be studied. For Spring 2011: Issues we will consider, in no particular order, include: Do properties exist? Why should you think there is an external world? What is a number? Why should you think other people have mental states? What are natural kinds? What constitutes the identity of things through time? What constitutes the identity of persons through time? What does determinism mean? Is there freedom of the will? What is possibility? What is necessity? Are there other possible worlds? When does one event cause another, and what does that mean? What could a deity be, and should you think there is one?.

80-276 Philosophy of Religion
Intermittent: 9 units
In order to expand our ideas about what religion could be, the course begins with a brief cross-cultural review of some major religious traditions around the world. Then we turn to some more traditional arguments for and against theism, including the ontological, cosmological, and design arguments, the argument from religious experience, the argument from miracles and historical testimony, and the problem of evil. We will also consider whether metaphysics ultimately depends on God (as it is in Carnegie Mellon) whether life would be meaningless if God did not exist.

80-280 Linguistic Analysis
Spring: 9 units
At one level, language is constituted by nothing but sounds, or marks on paper. How can such physical objects be used to create or transmit meaning? The answer assumed in this course is that objects with specific physical features are assigned symbolic or linguistic values on the basis of those features. By the juxtaposition of such objects (phonemes or graphemes), larger symbolic objects are created (morphemes). These larger objects have the special property that they can be associated in a consistent way with meanings. In a progressive fashion, words are built from morphemes, phrases from words, and sentences from phrases. The symbolic object of special importance in language is the sentence — this is the minimal object that encodes information. Sentences have different moods, and these moods correspond to their function with respect to the encoding and transmission of information. Indicative sentences carry information, interrogative sentences request information, imperative sentences demand action, conditional and modal sentences present alternative possibilities, and so on. The goal of this course is to investigate the association of sound and meaning (or marks and meaning) in stages, beginning with the combinations of phonemes or graphemes into morphemes, and moving on to the construction of larger syntactic entities, ultimately sentences. Building on material taught in Nature of Language, formal theory in the areas of morphology, syntax, and semantics is introduced as we proceed, and as motivated by the linguistic forms under analysis. The endpoint involves the representation of meaning in language, and a consideration of what information is, such that it can be encoded in and transmitted by simple physical entities. Corequisite: 80-180.

80-281 Language and Thought
Intermittent: 9 units
This course addresses issues related to the connections between thought and language, particularly the ways in which we express thoughts and attitudes through language. Is language necessary for thought? What are the referents of linguistic expressions: cognitive or mental entities of some sort, or things out there in the world? Does the meaning of sentences come before their truth conditions, or the truth conditions of an expression are sufficient to determine its meaning? What kind of knowledge makes it possible for speakers of a language to communicate with one another? Is the meaning of expressions determined by norms and social conventions? What is a metaphor? What exactly serves as the context of an utterance in discourse? Do speakers of different languages perceive the world differently because of their language differences? The first part of the course addresses classical philosophical issues concerning the relation of truth and meaning, as well as issues related to the meaning of verbs of propositional attitude and pragmatics. The second part of the course focuses on more recent proposals in cognitive semantics, particularly theories that utilize conceptual spaces as the main framework to represent semantic information. We will also consider ‘hybrid’ theories that describe the form-meaning relation as an idealized account of the process whereby the recipient of an utterance comes to grasp the thoughts that the utterance contains. A basic course in logic is recommended but not required.

80-282 Phonetics and Phonology
Fall: 9 units
This course seeks to describe the sounds of human languages in a linguistically relevant fashion. The challenge is that at a sheer physical level, every speech sound is different than every other speech sound. This is true within the speech of an individual, between sounds produced by different speakers of the same dialect, and across dialects within a language. Still, some sounds are considered by speakers to be the same as other sounds, and this is a crucial property, making spoken language possible. On the flip side, sounds must also be recognized as different from each other. This is the phonological concept of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning. In this course students get hands-on practice in describing sounds in articulatory and acoustic terms (how they are made and what their physical properties are) and in using these descriptions to study the phonological systems of contrast and without it, sounds could not be combined together as morphemes to carry meaning.
80-283 Syntax and Discourse
Spring: 9 units
This course builds on and expands the basic syntactic analysis skills learned in 80-180 Nature of Language, and applies them to an exploration of the ways in which syntactic structure can be manipulated in different languages to reflect the status of content as old or new, foregrounded or backgrounded, connected to ongoing discourse or not. More generally, the course provides an examination of the interaction between syntactic structure and discourse structure, with reference to English and other languages. The course will begin with review of the basic syntax from Nature of Language (head/argument structure, constituency tests, complement/adjunct distinction) and will then develop this basic syntactic theory further, based on analysis of declarative sentences in English and one other language. We will then begin the analysis of manipulations of basic sentence structure such as fronting, left- and right- dislocation, clefting and passivization, exploring in parallel the syntactic description of such structures and their semantic/pragmatic functions, using appropriate theoretical concepts. The course will provide students with tools to reason about and represent syntactic structure, and to accurately characterize the discourse-related properties of different sentence types. Prerequisite: 80-180
Prerequisite: 80-180.

80-291 Issues in Multimedia Authoring
Fall: 9 units
This course emphasizes the philosophical, cultural, and sociological aspects of multimedia. The course will explore these issues historically and thematically by looking at central figures in the early days of computers and communication theory (e.g., Alan Turing and Claude Shannon) and recent work by writers such as Brenda Laurel (Computers as Theatre), George Landow (HyperText 2.0), and Janet Murray (Hamlet on the Holodeck: The Future of Narrative in Cyberspace). This is not a technical course in issues relating to the creation of multimedia software. It is a course concerned with the meaning of multimedia authoring in its contemporary societal context.

80-305 Rational Choice
Fall: 9 units
This course will cover selected topics in rational choice theory, which informally is the analysis of how to make a correct decision in a given context. The course offers an introduction to the main normative theories of rational choice: von Neumann-Morgenstern theory of expected utility, Anscombe-Aumann’s account and Savage’s theory of choice under uncertainty. The course also includes an introduction to the main descriptive accounts of decision making used in Psychology and Economics. Possible topics may include, and are not limited to: a review of the main theories of non-expected utility and related issues in the psychology of judgment and decision making (especially recent advances extending Rank Dependent Utility and Prospect theory from risk to uncertainty), game-theoretic problems of conflict and coordination, the role of heuristics in choice behavior and strategic reasoning, as well as recent theories that abandon the Bayesian assumption that the decision maker’s beliefs can always be represented by a unique probability distribution. This course will stress the role that formal methods can play in the analysis of decisions and alternative applications of decision theory to issues in philosophy and social science.

80-310 Formal Logic
Fall: 9 units
Among the most significant developments in modern logic is the formal analysis of the notions of provability and logical consequence for the logic of relations and quantification, known as first-order logic. These notions are related by the soundness and completeness theorems: a logical formula is provable if and only if it is true under every interpretation. This course provides a formal specification of the syntax and semantics of first-order logic and then proves the soundness and completeness theorems. Other topics may include: basic model theory, intuitionistic, modal, and higher-order logics. Prerequisites: 15-251 or 80-210 or 80-211 or 80-212.

80-311 Undecidability and Incompleteness
Spring: 9 units
The course focuses on two central problems of mathematical logic: the undecidability of predicate logic (established by Church and Turing) and the incompleteness of formal theories (discovered by Gödel for theories that contain a modicum of set or number theory). The solutions of these problems involve the concept of computation that turned out to be fundamental for computer science, but also cognitive science. We first discuss predicate logic and systematic ways of constructing proofs; that is followed by the formal development of elementary set theory. The concept of Turing machine computation is introduced and shown to be equivalent to the concept of recursive function. That provides the mathematical, methodologically adequate tools for establishing the results mentioned above. The mathematical and computational notions and results are among the most significant contributions of logic, not just to the solution of internal logical questions and to the foundation of computer science, but also to (the beginnings of) a deeper understanding of the human mind and mental processes. Prerequisites: 15-251 or 21-300 or 80-210 or 80-211 or 80-310.

80-312 Philosophy of Mathematics
Intermittent: 9 units
The 20th century witnessed remarkable and novel developments of mathematics - with deep roots in the 19th century. The beginnings of these developments were beset with foundational problems and provoked a variety of programmatic responses: logicism, intuitionism, and finitism. For a deeper study of basic issues, we review a part of classical Greek mathematics (the theory of proportions) that is closely connected to the foundations of analysis in the 19th century. We analyze set theoretic and constructive approaches, and discuss fundamental metamathematical results and their philosophical implications. A “reductive structuralist” position will finally provide a perspective for understanding the abstract character of mathematics as well as its usefulness in applications. Prerequisites: 80-211 or 80-310 or 80-311.

80-313 Philosophical Logic
Intermittent: 9 units
A survey of the areas of logic that every philosophical logician must know, most philosophers should know, and any philosophy student may wish to know: modal logic, epistemic, dynamic, deontic, and temporal logics, intuitionistic logic, higher-order logic, constructive logic and type theory, relevance logic, conditional, Kripke semantics, Scott-Montague Semantics, probabilistic semantics and others. In various cases we will discuss recent work including unpublished papers and book drafts. We will consider both the formal details and the philosophical adequacy of the various surveyed formalisms. Prerequisites: 80-310 or equivalent.

80-314 Logic and Artificial Intelligence
Intermittent: 9 units
An introduction to several formalisms used in knowledge representation and database theory. The emphasis is placed on non-monotonic logic, conditional logic and belief revision methods. We will also study recent issues in the logics of knowledge and belief and consider applications in distributed AI. Several methodological problems in AI are discussed.

80-315 Modal Logic
Intermittent: 9 units
This course is an introduction to first-order modal logic. After a thorough grounding in propositional normal modal logic, which covers rudimentary modal model theory (invariance results, the relationship between modal and first-order logic, the finite model property, and notions of modal model equivalence), soundness, completeness, and basic decidability results, several interpretations and applications of normal modal logics are considered. Modal languages are simple languages for talking about relational structures, with several applications appearing in philosophy, computer science, and linguistics. Some examples the course may touch upon include temporal and epistemic logics, multi-agent systems, finite parse trees, labeled transition systems, among others. In the last part of the course we will consider extensions of the Kripke models to interpret first-order modal languages, and close with the more general still Scott-Montague models of “classical” modal logic and extend those to first-order modal languages.
80-321 Causation, Law, and Social Policy
Intermittent: 9 units
Policy makers face causal questions. For example, does violence on TV cause violence in life, and if so, what policies can we institute that will actually curb it? Does the death penalty actually deter criminals? Do tough drug laws reduce drug use? This course investigates how scientists establish causal claims, and how policy makers and the courts rely on or systematically ignore such science. We examine what causal claims mean and how they connect to statistical data, and we discuss the limits of standard techniques for establishing causal claims. We will consider all of these issues first theoretically, and then in the context of several case studies chosen mostly by the students. Knowledge of social science and/or statistics is not required, but is desirable. Prerequisite: 36-201.

80-322 Philosophy of Physics
Intermittent: 9 units
Philosophical problems in the development of modern physics. Topics include the philosophical significance of Einstein's theory of relativity, interpretations of quantum mechanics, and the relationship between these two theories. Other topics may include the philosophy of space and time, the epistemology of geometry, the significance of modern cosmology, and chaos theory.

80-323 Philosophy of Biology
Intermittent: 9 units
This course will focus on a range of foundational problems in evolutionary biology, including the possibility of meaningful explanations and laws, evolutionary explanations of human behavior from sociobiology and evolutionary psychology, and controversies over the meanings and roles of a variety of foundational concepts (including fitness, adaptation, optimality, and probability). Philosophers have historically played a central role in these debates, and so we will also examine the ways in which the theory and practice of evolutionary biology have changed in light of philosophical arguments and observations. This course will be accessible both to philosophers interested in the epistemological and metaphysical status of evolutionary biology, and to biologists interested in better understanding the foundations of their field. Although there are no formal prerequisites for this course, students will be expected to have taken courses in either philosophy or biology.

80-335 Deliberative Democracy: Theory and Practice
Spring: 9 units
This course will explore the theory and practice of deliberative democracy. Topics and concepts to be discussed include distinctions between aggregative and deliberative models of democracy, the notions of Reciprocity, Publicity, and Accountability as they apply to policy discussions, and recent work in Citizenship Theory. We will also look at various practices that utilize the theories of deliberative democracy, such as Participatory Strategic Planning, Deliberative Polls®, and Action Forums.

80-337 Philosophy Politics & Economics
Intermittent: 9 units
The course is split between two broad topics. First, we explore issues pertaining to Individual Decision Theory, mainly the postulate of rationality and its implications. We then proceed to discuss collective decision making by a group of rational agents. We discuss methods of aggregating individual preferences and, in particular, measures of social welfare, in an effort to associate the evaluation of policy with ethical principles.

80-341 Computers, Society and Ethics
Intermittent: 9 units
This course explores many of the social and ethical issues that have emerged in the wake of the significant advances that we have witnessed in computer science and information technology (IT). Computers and communications technologies have had an increasing impact on the whole of society and have raised new and difficult ethical questions. In turn, these ethical issues have spurred the need for a consideration of new policies and regulations. In this new world of IT, some are concerned about the protection of their privacy while others find problems of censorship and, more generally, restrictions on information access to be their main focus as a problematic social issue. This course will address these and other issues such as: questions of free speech, surveillance in the workplace, intellectual property and copyright, information acquisition and ethics and the Internet.

80-344 Management, Environment, and Ethics
Intermittent: 9 units
This course examines and poses answers to the following question: “What are the legitimate environmental responsibilities of organizational managers from the private, public and nonprofit sectors and how can they be best fulfilled?’’ This query will provide the course with its major theme and framework. But in order to do justice to it, three interconnected areas that are presupposed by this question will need to be explored first. These areas are: 1) applied ethics, 2) management ethics and 3) environmental ethics. The first half of the course will concentrate upon these three areas. The second half of the course will focus upon management and the environment employing the insights gained during the first half. Here students will review and evaluate past and current management practices with respect to the environment, organizational policies dealing with the environment and the role of government in the process of determining environmental responsibilities in management. Environmental concerns on the international level and their impact upon organizational management, the emergence of the “environmental affairs manager” within organizations, balancing environmental responsibilities with other management responsibilities and examples of management responses to the environmental crises will also be examined during this portion of the course.

80-348 Health Development and Human Rights
Intermittent: 9 units
Approximately 1.1 billion people live on less than $1 a day in a condition the World Bank refers to as extreme poverty. Those who live in extreme poverty frequently lack effective access to proper nutrition, adequate shelter, safe drinking water, and sanitation. As a result, they also bear the greatest burdens of famine and epidemic disease and frequently face social and political conditions of unrest and systematic oppression. This course examines the question of what, if anything, we in the technologically and economically developed world owe to the global poor. It therefore focuses considerable attention on competing theories of global distributive justice and the relationship between poverty, poor health, and human rights. We will critically examine different strategies for international development that emphasize one or more of these variables and we will consider how information about the complex interrelationship of these variables should be factored into the development process.

80-351 Kant
Intermittent: 9 units

80-365 Ramsey
Intermittent: 9 units
Frank Ramsey played a crucial intellectual role in the Cambridge of Russell, Moore, Wittgenstein and Keynes (just to mention some central figures of the exceptionally lively and creative atmosphere of Cambridge at the beginning of the past century). During his short life (he died in 1930 at the age of only 26) he made decisive contributions to epistemology, decision theory, philosophical and mathematical logic, philosophy of mathematics, metaphysics and philosophy of science. Just to mention an example, his paper ‘Truth and Probability’ laid the foundations of the modern theory of subjective probability and also those of modern utility theory and decision theory. The entire core of Ramsey’s philosophical and scientific work consists of no more than 15 papers. But in all cases they are remarkable essays that changed the intellectual topics they touched. Moreover they all contain the same view of philosophy merging a sound portion of Moorean realism with Ramsey’s kind of pragmatist philosophy. The course reviews these central papers and its rich relations with the Cambridge philosophers of this time and the Vienna Circle. In addition it is remarkable that most of Ramsey’s views remain valid today almost a century after his death. So, the course considers as well the impact of Ramsey’s views in contemporary analytic philosophers and those influenced by early American pragmatism.

The Ramsey Collection at the University of Pittsburgh comprises an almost complete collection of autograph material by Ramsey, roughly 1.500 autograph pages in all. I am doing some historical research on this material which I intend to incorporate as additional material for the course.
80-380 Philosophy of Language
Intermittent: 9 units
Philosophy of language involves the attempt to understand the nature of language and its relationship with speakers, their thoughts, and the world. As part of this attempt, philosophers have asked questions such as: What is language? How does language convey meaning? Is it language itself which determines meaning, or the intentions of speakers? What different kinds of meaning are there? Philosophers and linguists have also asked questions about the meanings and functions of particular linguistic forms, such as definite noun phrases, conditional sentences and words like “I” and “now.” In this course, we will read papers by many of the major figures of contemporary philosophy of language: Frege, Russell, Tarski, Davidson, Quine, Kaplan, Grice and others. The course will be run “seminar-style”: students will be expected to read papers for each class in preparation for class discussion, and will also be required to take turns presenting the papers in class. The course also has significant writing requirements. By the end of the course, students will be familiar with the central questions of this area of philosophy, with the type of argumentation used to address them, and with some of the solutions that have been proposed. Students enrolling in the course should have taken at least one other philosophy class in which they read papers from the philosophy literature.

80-381 Meaning in Language
Fall: 9 units
This course is an introduction to the study of meaning from a linguistic perspective. Linguists studying meaning need to be able to say what the meanings of sentences are, and to explain how those meanings are constructed from the meanings of sentence parts: words, morphemes and syntactic structure. In this course, we’ll focus on developing a vocabulary for talking about the truth conditional content of sentences: the part of meaning that has to do with representing the world as being a particular way. We’ll also investigate how particular words and constructions affect the appropriateness conditions of sentences in which they occur, that is, the conditions under which those sentences can be appropriately used in discourse. As we’ll see, many linguistic items affect sentence meaning in both of these ways simultaneously. The semantic contributions of a wide range of linguistic forms will be covered in the course. By the end of the semester, you will be able to state clearly what the difference is between the noun phrases “a dog” and “the dog”; you’ll understand the difference between the sentence “All dogs have tails” and the sentence “Dogs have tails”; and you’ll know why the sentence “John left yesterday” sounds fine but the sentence “John has left yesterday” doesn’t. You’ll know how to talk about the meanings of sentences with modals, like “John might have left”, and you’ll understand what the difference is between saying “JOHN didn’t see Bill” and saying “John didn’t see BILL.” All this, and more. While the course will develop precise ways of talking about meaning, it will not be particularly technical. (The amount of technical material to be introduced will be determined on the basis of the skills and interests of students.) Material in the course will presuppose a basic knowledge of linguistic notions, as covered in 80-180 Nature of Language. Prerequisite: 80-180.

80-382 Linguistics of Germanic Languages
Spring: 9 units
In this course we will look at phonology and syntax within a single language family, Germanic. The Germanic languages include English, Dutch, Frisian, German, Pennsylvanisch, Afrikaans, Yiddish, Icelandic and the Scandinavian languages, excluding Finnish. Similarities and differences in the sound systems of these closely related languages will be studied, and we will also look comparatively at various syntactic structures, including noun phrases, verb complements, main and relative clauses, as well as mood and modality. The approach is student-centered, with groups of students concentrating on topics in a few most-closely related languages. The course will provide an extended case-study for application of concepts and analytical strategies taught in Nature of Language, Phonetics and Phonology, Linguistic Analysis, and other relevant courses. The approach should also help bring out the relevance of diachronic factors in the synchronic study of language, with historical forms of English being open to investigation, as these often reflect patterns found in contemporary Germanic languages. Prerequisite: 80-180.

80-383 Language in Use
Fall: 9 units
Why is it so hard to get computers to chat? The reason is that when we have an ordinary, casual conversation we do a great deal more than merely exchange information which is directly encoded in language. We also recognize what our interlocutors intend to accomplish with their utterances; we use and recognize utterances with indirect meanings, as well as metaphors, jokes and irony; we fill in incomplete or underspecified meanings; and we determine what kinds of responses are desired and appropriate. We do all of this in part on the basis of linguistic knowledge, but also making use of implicit reasoning about speaker plans and intentions, and relying on implicit assumptions about normal conversational behavior. In this course, we will investigate language in use, taking the approach developed within the linguistic sub-field of pragmatics. We focus on three related issues: First, we look at how language is used to do things, studying both the traditional theory of speech acts and a more contemporary approach. Second, we look at expressions whose function is primarily interactional. Finally, and most extensively, we examine how speakers can successfully express meanings that go beyond what is encoded by the linguistic forms that they use. The course is open to students at the sophomore level and above.
Prerequisites: 80-100 or 80-180.

80-405 Game Theory
Spring: 9 units
Game theory is the branch of decision theory in which decision problems interact. This course will cover those parts of game theory of special interest to social scientists and philosophers. We will discuss specific elements of the formal theory, including: the distinction between cooperative and non-cooperative games, games in the strategic and the extensive form, solution concepts, epistemic conditions needed to predict outcomes of games, equilibrium refinements, dynamical models of equilibrium selection, and folk theorems of indefinitely repeated games. We will discuss results in experimental economics that test some of the assumptions of classical game theory. Throughout the course we will examine applications of the formal concepts of game theory to problems in moral and political philosophy and the social sciences. Prerequisites: background either in decision theory, rational choice, probability, or statistics.

80-411 Proof Theory
Intermittent: 9 units
This course is an introduction to Hilbert-style proof theory, where the goal is to represent mathematical arguments using formal deductive systems, and study those systems in syntactic, constructive, computational, or otherwise explicit terms. In the first part of the course, we will study various types of deductive systems (axiomatic systems, natural deduction, and sequent calculi) for classical, intuitionistic, and minimal logic. We will prove Gentzen’s cut-elimination theorem, and use it to prove various theorems about first-order logic, including Herbrand’s theorem, the interpolation theorem, the conservativity of Skolem axioms, and the existence and disjunction properties for intuitionistic logic. In the second part of the course, we will use these tools to study formal systems of arithmetic, including primitive recursive arithmetic, Peano arithmetic, and subsystems of second-order arithmetic. In particular, we will try to understand how mathematics can be formalized in these theories, and what types of information can be extracted using metamathematical techniques. Prerequisites: 21-300 or 80-310 or 80-311.

80-413 Category Theory
Intermittent: 9 units
Category theory is a formal framework devoted to studying the structural relationships between mathematical objects. Developed in the mid-20th century to attack geometrical problems, subsequent progress has revealed deep connections to algebra and logic, as well as to mathematical physics and computer science. The course emphasizes two perspectives. On one hand, we develop the basic theory of categories, regarded as mathematical structures in their own right. At the same time, we will consider the application of these results to concrete examples from logic and algebra.
80-447 Global Justice
Intermittent: 9 units
Until recently, the dominant view of international relations among both academics and politicians was that governments and citizens of one country have no moral or legal obligations to anyone beyond their own borders. The later half of the 20th century has seen a dramatic change in this attitude, with a much greater willingness to recognize that demands of justice may transcend national borders and bind different states and their people. This course examines this shift through the lenses of history, philosophy, law, politics, and anthropology. It is being offered in conjunction with the 2009-2010 Humanities Center Colloquium Series on “Global Connections, Global Responsibilities.” Topics covered include: theories of justice; sovereignty; the universality of human rights; global inequality and poverty; trade and labor in the global economy; climate change; humanitarian intervention and just war; post-conflict reconciliation and social reconstruction; as well as the emergence of transnational modes of governance. In addition to several short writing assignments, students will have the opportunity to carry out a research project on a relevant topic of their choice.

80-449 EHPP Project Course
Fall: 12 units
The Ethics, History and Public Policy Project Course is required for the Ethics, History and Public Policy major and is taken in the fall semester of the senior year. In this capstone course, Ethics, History and Public Policy majors carry out a collaborative research project that examines a compelling current policy issue that can be illuminated with historical research and philosophical and policy analysis. The students develop an original research report based on both archival and contemporary policy analysis and they present their results to a client organization in the community.

80-511 Thesis Seminar
Intermittent: 9 units
This course provides a forum for the presentation and detailed discussion of research done by students, be they undergraduates working on their Senior Thesis or graduate students engaged with their M.S. thesis.

80-513 Seminar on Mathematical Understanding and Cognition
Fall: 9 units
Algebra and number theory in the nineteenth century Jeremy Avigad (Carnegie Mellon) and Ken Manders (University of Pittsburgh) (This seminar is listed jointly between the two universities). A number of questions regarding the types of equations that can be solved in the integers and in the reals have their origins in antiquity, when mathematics was held to be the science of quantity, both continuous (magnitude) and discrete (number). The beginning of the nineteenth century brought striking advances along these lines. For example, Gauss gave a detailed analysis of the integrals that can be represented by a given quadratic form, and both Abel and Galois showed that the general quintic equation has no solution by radicals. A good deal of effort in the nineteenth century was devoted to making sense of these results, and by the end of the century the ideas had been recast in algebraic structural terms. Galois theory and the study of quadratic forms are now invariably presented in terms of field extensions and their properties. This shift is prototypical of the transition to the “modern” view of mathematics. In this seminar, we will trace the development of these ideas. We will focus, as much as possible, on the original sources, with an eye towards obtaining a better understanding of the methodological considerations that drove these developments.

80-514 Categorical Logic Seminar
Fall: 9 units
This course focuses on applications of category theory in logic and computer science. A leading idea is functorial semantics, according to which a model of a logical theory is a set-valued functor on a category determined by the theory. This gives rise to a syntax-invariant notion of a theory and introduces many algebraic methods into logic, leading naturally to the universal and other general models that distinguish functorial from classical semantics. Such categorical models occur, for example, in denotational semantics. e.g. treating the lambda-calculus via the theory of Cartesian closed categories. Similarly, higher-order logic is treated categorically by the theory of topos. Note: this course will begin with a 3 week refresher of basic category theory - CS students can start after immigration by reviewing on their own.
Prerequisite: 80-413.

80-516 Seminar on Causation
Fall
This course explores the foundations of causation. It examines how causal claims connect to both probability and to counterfactuals. Under a variety of background assumptions, and a variety of senses of “reliable”, we will examine which causal inferences can be made reliably. We will also examine recent developments in statistics and artificial intelligence relating to causal inference.
Prerequisite: 80-316.

80-520 Seminar on Philosophy Science: Evolutionary Game Theory and Application
Fall: 9 units
Seminar on Philosophy of Science: Evolutionary Game Theory and Applications Evolutionary game theory (EGT) represents one potential foundational theory which grounds traditional game theory models. EGT relaxes the “high rationality” assumptions of traditional game theory in favor of conceptualizing individuals as subject to evolution by natural selection or some form of trial and error learning. EGT provides a justification for many of the traditional concepts in game theory, but also highlights potential problems with this theory. This course will provide an overview of evolutionary game theory, and then will investigate two applications of that theory. The first application is the explanation of pro-social behaviors including cooperation, fairness, and altruism. The second application is to the emergence of linguistic behaviors, especially in non-human animals.
Prerequisites: 80-413 or 80-713.

80-521 Seminar on Formal Epistemology
Spring: 9 units
Formal epistemology applies systematic mathematical models from logic, statistics, and computability theory to provide fresh perspectives on traditional epistemological questions regarding the nature of epistemic justification, vagueness, paradoxes of knowing, paradoxes of rationality, the nature of bounded rationality, and the connection between coherence, epistemic justification and truth. The course will critically examine published papers, many of which were presented at the Formal Epistemology Workshop in recent years.

80-522 Seminar on the Foundation of Statistics
Fall: 9 units
The seminar focuses on some single important foundational work, or body of work, and investigates it and related research from a contemporary point of view. For example, when Savage’s Foundations of Statistics is the course’s focus, the class goals include understanding how Bayesian decision theory differs from its rivals, and understanding where Savage’s position is located within the current Bayesian program. Other seminal thinkers whose writings have served as the course’s focus in different terms include, R.A. Fisher, Harold Jeffreys, J. Neyman, and A. Wald. Prerequisites: This is primarily a graduate level class. Instructor permission is required for undergraduates.

80-575 Seminar on Metaphysics
Instructed
We will begin, appropriately, with readings from Plato and from Aristotle’s Metaphysics, which motivate the fundamental questions of metaphysics. With this classical background, we will turn to a range of contemporary articles concerning such traditional metaphysical questions as the nature of existence, necessity, and causation, the persistence of objects through time, and personal identity. This is an advanced undergraduate class.
**80-580 Seminar on the Philosophy of Language**

Intermittent: 9 units

Seminar on the Philosophy of Language: The Construction of Meaning. The prevailing standard model of linguistic interpretation traces back to the work of Paul Grice. On Grice's model, the interpretation of a linguistic utterance is a two stage process. First, an interpreter calculates the meaning of the sentence uttered on the basis of the conventional meanings of the words and syntactic constructions used. The output of this compositional process is assumed to be a proposition. Then, the interpreter proceeds to make inferences, based on this proposition and other contextual information, as to what the speaker meant. Crucially, this process (a) treats the truth conditional content of sentences as compositionally determinable on the basis of purely linguistic information and (b) clearly separates the contribution of semantic processes and pragmatic (inferential) ones. This standard picture has been critiqued from a variety of perspectives, and there is an ongoing debate surrounding the theory of the construction of meaning. Some philosophers and linguists have argued that inferential processes indeed do contribute to the determination of truth conditional content, or "what is said." Others defend some version of the standard view, and have provided a variety of responses to critiques. Both kinds of view come in different degrees, ranging from extreme contextualists to those who deny that naive intuitions about utterance interpretation provide insight into the actual meanings of sentences. In this seminar, we will read the literature in which this debate has been and is being carried out. Readings will primarily be drawn from the philosophical and linguistic literature, with some forays into psycholinguistics and computational linguistics.

**80-595 Senior Thesis**

Fall and Spring

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**Physical Education Courses**

**69-101 Racquetball**

Fall and Spring: 3 units

This course is designed to aid in developing the fundamental skills involved in racquetball. Techniques, rules and strategy are stressed. It is hoped that the student will develop a reasonable level of proficiency to enable participation on a leisure-time basis.

**69-102 Weight Training**

Fall and Spring: 3 units

This course is designed to provide the opportunity for the inexperienced student to learn the effectiveness of a carefully planned weight-training program as a method of body development and the contributing benefit to performance in many sports.

**69-103 Advanced Recovery & Restoration**

Spring: 3 units

This course is designed to provide the opportunity for the physically active student to learn the effectiveness of a carefully planned recovery and restoration techniques as a method of body development and the contributing benefit to performance in many sports.

**69-104 Practical Application of Sports Nutrition for Competitive Athletes**

Spring: 3 units

This course will cover the following topics: macronutrient overview, specific overview of fats, carbohydrates, and protein, vitamin and minerals, nutritional needs for strength/power and endurance athletes, pre/during/ post training nutritional needs for strength/power and endurance athletes, and other topics. FOR UNDERGRAD STUDENTS ONLY.

**69-105 Agility & Circuit Training**

Spring: 3 units

This course is designed to train the entire body combining fitness and core body work. We will do jumping and agility exercises to increase explosiveness and foot speed. Circuit training will be used to strengthen your core, arm, and leg muscles and will provide a cardiovascular workout.

**69-106 Intro to Recreation**

Fall: 3 units

This is a basic level class for first-year students only. This class is designed to teach students various fitness and recreational activities available to them on campus.

**69-107 Walking for Fitness**

Fall: 3 units

This course is an aerobic conditioning activity. A fast paced walk that is less wear and tear on your joints than what a running program will do.

**69-110 Personal Fitness**

Fall and Spring: 3 units

This course will be a conditioning course prescribed partially by the individual with assistance from the instructor to insure that the desired results will be achieved or at least pursued correctly. Individual goals will be the main concern. Stretching, aerobics, weight training and nutrition will be discussed.

**69-112 Fitness Fusion**

Fall and Spring: 3 units

A fun power-packed workout designed to introduce all aspects of fitness. This class combines simple exercises including cardio endurance with dynamic balance and stabilization. The class will fuse fitness while maximizing the benefits offered by training with concise, innovative, and effective exercises for the whole body. Every few weeks another aerobic activity will be added. We will start slowly so you can experience progressions and advance your training. During the fusion of strength, core, and flexibility, we will use a variety of "toys" to enhance your fun and fitness while fusing the total package of mind, body, and spirit.

**69-113 Beginning Karate**

Fall and Spring: 3 units

Beginning Karate teaches traditional Tang Soo Do (Korean Karate) by Master C. S. Kim and assistant instructors with specific standards and goals designed to help each student maximize potential as an individual, as well as a martial artist. Students will learn stretching and basic stances as well as blocking, punching, kicking, knee and elbow strikes, and open-handed techniques such as knife-hands. Proper etiquette will also be taught.

**69-114 Intermediate Karate**

Fall and Spring: 3 units

Intermediate Karate teaches a higher level of the traditional martial arts with specific standards and goals designed to help each student maximize potential as an individual, as well as a martial artist. Through traditional Tang Soo Do (Korean Karate) taught by Master C. S. Kim and assistant instructors, you will find many opportunities to gain specific knowledge which will apply not only in your martial arts training, but also in the improvement of your daily quality of life.

**69-119 Advanced Recovery Defense Systems (RAD)**

Fall and Spring: 3 units

Self Defense for Women - is a course specifically designed to increase women's awareness of potential sexual assault and to provide physical techniques to respond to such an act. It is intended for women only because it is believed that the presence of males in class (other than instructors or other authorized persons) can alter the emotional and physical responses of women to class material and thereby hinder their ability to reach course objectives. It is of the utmost importance that women be able to maximize their opportunity to learn in the company of like-minded students. The core of the course is based upon the principles of the Rape Aggression Defense System (R.A.D.) which was conceived and developed by Larry N. Nadeau. His goal in developing R.A.D. is also its motto: "To develop and enhance the options of self-defense, so they may become viable considerations to the woman who is attacked." This course is composed of three sections: risk reduction principles, physical defense techniques, and simulation. Risk reduction principles include a thorough review of personal self-awareness & the environment, whether in the home, neighborhood, or unfamiliar community. Physical defense techniques include the introduction to bodily strikes with hands, kicks with the feet, and defenses against grabs & holds. Simulation is the activity that attempts to incorporate, via physical demonstration, all emotional & physical techniques that have been taught through the acting out of scenarios involving instructors (padded/protected) as attackers, and students (padded/protected) responding to the assault.

**69-120 Beginning Tennis**

Fall and Spring: 3 units

This course is designed to familiarize the student with the rules of tennis and to develop the skills needed to become proficient for recreational play. During the first half of the course, all tennis strokes will be covered and reviewed in detail. The second half of the course will focus mostly on competitive games and match-play.

**69-121 Volleyball**

Spring: 3 units

This course is designed to familiarize the student with the rules of volleyball and to develop the skills needed to become proficient for recreational play.

**69-122 Advanced Tennis**

Fall: 3 units

This course will consist mainly of tennis drills and discussions related to singles, doubles, and match strategy. In addition to being able to successfully execute all tennis strokes, students should also already have significant tennis match experience.
69-134 Beginning Golf
Fall and Spring: 3 units
This course is designed to give the student all the skills necessary to play a satisfactory game of golf. The long game, the short game and putting are covered. It is a leisure time sport that is challenging and can be used by the student for the rest of his/her life.

69-135 Soccer Skills
Fall: 3 units
This course is designed to familiarize the student with the rules of soccer and to develop the skills needed to become proficient for recreational play.

69-136 Basketball Skills
Fall and Spring: 3 units
This course is designed to familiarize the student with the rules of basketball and to develop the skills needed to become proficient for recreational play.

69-137 Ultimate Frisbee
Fall: 3 units
This class is designed to teach basic Frisbee skills. This class is a great conditioning/cardio class with high energy. It is a fun team game to play.

69-139 Indoor Soccer Skills
Fall and Spring: 3 units
This course is designed to familiarize the student with the rules of soccer and to develop the skills needed to become proficient for recreational play.

69-140 Squash
Fall and Spring: 3 units
This course is designed to aid in developing the fundamental skills involved in squash. Techniques, rules and strategy are stressed.

69-142 Beginning Fencing
Spring: 6 units
This course will cover the basic skills needed for fencing with the foil. Footwork, attacks, and defenses will be practiced. Competition rules and strategies will be discussed. Students will fence each other and the instructor in almost every class.

69-143 Floor Hockey/Dodgeball
Spring: 3 units
This class is designed to teach two team sports that are fun and great exercise. Both classes will be taught basic skills to succeed in the games.

69-144 Diamond Sports
Spring: 3 units
This course is designed to familiarize the student with the rules of softball and wiffleball and to develop the skills needed to become proficient for recreational play. Students will play each other or the instructor in almost every class.

69-145 Sports Officiating
Fall and Spring: 3 units
The sports officiating class is an introduction to the rules and mechanics for a variety of Intramural Sports. Students will learn how to properly officiate basketball, flag football, soccer, and softball. Class sessions will be a combination of interactive lectures and hands-on game experience.

69-146 Team Handball
Fall: 3 units
Team Handball or European Handball - This is an introductory level class that will cover the basics of the sport including the rules, organization, and basic game play. Students will be expected to learn the rules and participate in play on a daily basis.

69-150 Beginning Swimming
Fall: 3 units
This basic course is designed to equip the non-swimmer with fundamental skills and knowledge to assure reasonable safety in, on or about the water. Areas covered include the basic swimming strokes, basic diving, safe and efficient entry into the water, and some elementary forms of rescue.

69-151 Introduction to Yoga
Fall and Spring: 3 units
This course is designed for the beginning yoga student who wants to gain a solid foundation of yoga poses and the benefits a yoga practice has to offer. The course is also for those who have experience in Yoga and want to practice and improve their basic skills. This class will be taught by Brian Dunn.

69-153 Lifeguard Training
Spring: 3 units
This course is the American Red Cross Lifeguard Training course. Students who complete certification will be eligible to be employed as lifeguards. Attendance is required. There will be a $90.00 fee for this class from the American Red Cross. This fee will be deducted from the student’s account once the status of the student is “enrolled and attending this class.”.

69-155 Cardio Fitness/Sculpt
Fall and Spring: 3 units
A total body fitness class for men and women that incorporates stretching for flexibility, exercises for strength and movement to increase cardiovascular improvement.

69-156 First Aid/CPR
Spring: 3 units
A basic course in treatment and care of injuries in emergency situations. Topics will include legal liability, prevention of injuries, nutrition and cardiovascular conditioning. The course will conclude with theoretical and practical application of cardiopulmonary resuscitation. Upon completion of the course students will receive Red Cross Certification. There will be a fee for this class at $15.00. This fee will be deducted from the student’s account.

69-157 Swimming Stroke Improvement
Fall: 3 units
This course is designed to provide the student with the opportunity to learn the elements of good swimming. A wide range of strokes, basic diving, safety, endurance, and versatility in the water will be covered for all students. Experienced swimmers will have the opportunity to perfect their strokes.

69-160 Swim-Fit
Fall and Spring: 3 units
You must know how to swim to take this class; this is not a learn-to-swim class. Pre and post timed swims, deep water treading, lap swimming interval training.

69-165 Cycling Core
Fall and Spring: 3 units
Indoor cycling classes are riding on a stationary bike while getting a great workout, experiencing several styles of training, and listening to music. All are welcome—beginner to advanced—you set the workout pace to various intensities. This course is for those participants who want to gain knowledge and experience of riding for endurance, speed work, race training, strength training, and/or visionary riding. Each class will be formatted to take the rider to their levels of advancement—beginner to advanced—all doing the same workout. Bikes are provided. No prior bike experience is necessary. No special footwear required—bike shoes are welcome—and tennis shoes at least are a must. Come along for the ride of a lifetime while having fun and getting into shape.

69-175 African-Caribbean Dance
Fall: 2 units
This class incorporates African-Modern dance technique (specifically elements of Dunham and Horton technique) and applies it to dance movements from West Africa, Haiti, and /or Brazil. Students will build strength, alignment, and stamina while experiencing the joy of dancing to the exciting and mesmerizing music of these regions. Open to non-drama and drama majors.

69-176 Non-Majors Jazz
Spring: 3 units
This class is designed for those students who would like to continue their study in jazz but are not enrolled in the CFA department. They will learn the basics and progression movements in the area of jazz dancing. This is for all levels of participants.

69-195 Emergency Medical Technician
Spring: 6 units
This course is designed to instruct a student to the level of Emergency Medical Technician-Basic. This includes all skills necessary for the individual to provide emergency medical service at a basic life support level with an ambulance service or other emergency service. Students who pass the state exam will receive Pennsylvania Accreditation as EMT-Basic.
Physics Courses

33-100 Basic Experimental Physics
All Semesters: 6 units
This course provides students with a basic introduction to experimental physics. The content of the course and the particular experiments to be carried out are chosen to be especially useful for students who intend to work in the health sciences. Specific topics will range from mechanics to nuclear and atomic physics. This course is specifically geared toward pre-health students.

33-101 First Years Seminar: Science and Science Fiction
Fall: 3 units
Various seminars are offered that introduce first-year students to current topics of modern physics. These are mini courses that meet for half a semester. In the past, seminar topics have included: Science and Science Fiction, Astrophysics, Black Holes, Cosmology and Supernovae, Elementary Particles, and The Building Blocks of Matter. These seminars are open only to MCS first year students.

33-104 Experimental Physics
All Semesters: 9 units
This course provides first year students and sophomores with an introduction to the methods of experimental physics. Particular emphasis is placed on three aspects of experimentation: laboratory technique, including both the execution and the documentation of an experiment; data analysis, including the treatment of statistical and systematic errors and computer-aided analysis of experimental data; and written communication of experimental procedures and results. The concepts and skills for measurement and data analysis are acquired gradually through a series of experiments covering a range of topics from mechanics to nuclear and atomic physics.

33-106 Physics I for Engineering Students
All Semesters: 12 units
This is a first semester, calculus-based introductory physics course. Basic principles of mechanics and thermodynamics are developed. Topics include vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton’s laws, gravitation, work, energy, momentum, impulse, temperature, heat, equations of state, thermodynamic processes, heat engines, refrigerators, first and second laws of thermodynamics, and the kinetic theory of gases. Corequisite: 21-120.

33-107 Physics II for Engineering Students
All Semesters: 12 units
This is the second half of a two-semester calculus-based introductory physics sequence for engineering students. The course covers waves, including standing and travelling waves, superposition, beats, reflection, interference, electricity, including electrostatics and electric fields, Gauss’ law, electric potential, and simple circuits, magnetism, including magnetic forces, magnetic fields, induction and electromagnetic radiation. Prerequisites: 21-120 and 33-106
Corequisite: 21-122.

33-111 Physics I for Science Students
Fall and Spring: 12 units
This calculus based course combines the basic principles of mechanics with some quantum physics and relativity to explain nature on both a microscopic and macroscopic scale. The course will build models to describe the universe based on a small number of fundamental physics principles. Some simple computer modeling will be done to develop insight into the solving of problems using Newton’s laws. Topics covered will include vectors, momentum, force, gravitation, oscillations, energy, quantum physics, center of mass motion, angular momentum, statistical physics, and the laws of thermodynamics. No computer experience is needed.
Corequisite: 21-120.

33-112 Physics II for Science Students
Fall and Spring: 12 units
This is the second semester course that follows 33-111. Electricity and magnetism is developed, including the following topics: Coulomb’s law, polarization, electric field, electric potential, DC circuits, magnetic field and force, magnetic induction, and the origins of electromagnetic waves. Prerequisites: 21-120 and 33-111
Corequisite: 21-122.

33-114 Physics of Musical Sound
Spring: 9 units
An introduction to the physics and psychophysics of musical sound. Elementary physics of vibrating systems. Propagation of sound: traveling waves, reflection, and diffraction. Addition of waves: interference and beats. Anatomy of the ear and the perception of sound: loudness, pitch, and timbre. Standing waves and natural modes. Qualitative description of general periodic systems by Fourier analysis: the harmonic series and complex musical tones. The acoustics of musical instruments including percussion instruments, such as drums, bars, and struck and plucked strings; and instruments exhibiting self-sustained oscillations, including bowed strings, blown pipes, reeds, brasses, and singing. Intervals and consonance, musical scales, tuning and temperament. Basic room and auditorium acoustics. There are no formal prerequisites, but an ability to read music and having some previous musical experience will be very useful.

33-115 Physics for Future Presidents
Fall: 9 units
Countless topics of social and political importance are intimately related to science in general and physics in particular. Examples include energy production, global warming, radioactivity, terrorism, and space travel. This course aims to provide key bits of knowledge based on which such issues can be discussed in a meaningful way, i.e., on the level of arguments and not just vague beliefs. We will cover an unusually wide range of topics, including energy, heat, gravity, atoms, radioactivity, chain reactions, electricity, magnetism, waves, light, weather, and climate. No calculus or algebra will be required. The course is open for all students at CMU.

33-120 Science and Science Fiction
Summer: 9 units
We will view and critique the science content in a selection of science fiction films, spanning more than 100 years of cinematic history, and from sci-fi TV shows from the past 50+ years. Guided by selected readings from current scientific literature, and aided by order-of-magnitude estimates and careful calculations, we will ponder whether the films are showing things which may fall into one of the following categories: Science fiction at the time of production, but currently possible, due to recent breakthroughs. Possible, in principle, but beyond our current technology. Impossible by any science we know. Topics to be covered include the future of the technological society, the physics of Star Trek, the nature of space and time, extraterrestrial intelligence, robotics and artificial intelligence, biotechnology and more. Success of this course will depend upon class participation. Students will be expected to contribute to discussion of assigned readings and problems, and to give brief presentations in class on assigned films.

33-124 Introduction to Astronomy
Fall: 9 units
Astronomy continues to enjoy a golden age of exploration and discovery. This course presents a broad view of astronomy, straightforwardly descriptive and without any complex mathematics. The goal of the course is to encourage non-technical students to become scientifically literate and to appreciate new developments in the world of science, especially in the rapidly developing field of astronomy. Subjects covered include the solar system, stars, galaxies and the universe as a whole. The student should develop an appreciation of the ever-changing universe and our place within it. Computer laboratory exercises will be used to gain practical experience in astronomical techniques. In addition, small telescopes will be used to study the sky. This course is specifically geared toward non-science/engineering majors.

33-131 Matter and Interaction I
Fall: 12 units
A more challenging alternative to 33-111, Physics for Science Students I. Students with particularly strong physics backgrounds may volunteer for this course. Modeling of physical systems, including 3D computer modeling, with emphasis on atomic-level description and analysis of matter and its interactions. Momentum, numerical integration of Newton’s laws, ball-and-spring model of solids, harmonic oscillator, energy, energy quantization, mass-energy equivalence, multiparticle systems, collisions, angular momentum including quantized angular momentum, kinetic theory of gases, statistical mechanics (temperature, entropy, and specific heat of the Einstein solid, Boltzmann factor). Corequisite: 21-120.
Fall: 12 units
A more challenging alternative to 33-112, Physics for Science Students II. Emphasis on atomic-level description and analysis of matter and its electric and magnetic interactions. Coulomb’s law, polarization, electric field, plasmas, field of charge distributions, microscopic analysis of resistor and capacitor circuits, potential, macroscopic analysis of circuits, Gauss’ law, magnetic field, atomic model of magnetism, Ampere’s law, magnetic force, relativistic issues, magnetic induction with emphasis on non-Coulomb electric field, Maxwell’s equations, electromagnetic radiation including its production and its effects on matter, re-radiation, interference. Computer modeling and visualization; desktop experiments.
Prerequisites: 21-120 and 33-131
Corequisite: 21-122.

33-201 Physics Sophomore Colloquium I
Fall: 2 units
This course (together with 33-202) is designed to give students an overview of the field of Physics and to help students make knowledgeable choices in both their academic and professional careers. We discuss several of the sub-fields of Physics in order to give students an understanding of the types of activities, from research to industrial applications, in each. Over the two semesters, we typically discuss six subfields in some detail with the goal of providing a minimal literacy in the relevant concepts and language. The course consists of one classroom lecture per week plus one hour per week of reading and/or problem solving.

33-202 Physics Sophomore Colloquium II
Fall: 2 units
Continuation of 33-201.

33-211 Physics III: Modern Essentials
Fall and Spring: 10 units
Physics III is primarily for third-semester students of physics, including all physics majors, but is open to any qualified student who wants an introduction to the physics of the 20th century. The course will have a strong component of Special Relativity, dealing with kinematics and dynamics, but not electricity and magnetism. (See 33-213 description.) It will introduce students to a conceptual theory, which is mathematically simple but (initially) non-intuitive. The course also provides a broad exposure to quantum phenomena and early quantum theory without getting overly mathematical. It leads into the more formal Quantum Physics course (33-234).
Prerequisites: 33-112 or 33-132 or 33-107.

33-213 Mini-Course in Special Relativity
Fall and Spring: 4 units
This course spans the first six weeks of 33-211, Physics III: Modern Essentials. It treats the Mechanics aspects of Special Relativity, including topics such as simultaneity, the Lorentz transformation, time dilation, length contraction, space-time geometry, resolving some famous puzzles, and the momentum, mass, and energy relations. The Electricity and Magnetism portions of the subject are deferred until the junior/senior courses in E&M (33-338/33-339).
Prerequisites: 33-112 or 33-132 or 33-107.

33-224 Stars, Galaxies and the Universe
Fall: 9 units
The study of astronomy has blossomed over the past few decades as a result of new ground-based and space-based telescopes, and with the advantage of fast computers for analysis of the huge quantities of data. As our astronomical horizon expands, we are still able to use the laws of physics to make sense of it all. This course is for students who want to understand the basic concepts in astronomy and what drives astronomical objects and the universe. The course emphasizes the application of a few physical principles to a variety of astronomical settings, from stars to galaxies to the structure and evolution of the universe. Introductory classical physics is required, but modern physics will be introduced as needed in the course. The course is intended for science and engineering majors as well as students in other disciplines with good technical backgrounds. Computer lab exercises will be used to gain practical experience in astronomical techniques. In addition, small telescopes are available for personal sign-out for those who would like to use them, and outdoor observing sessions will be organized as weather permits.
Prerequisites: 33-106 or 33-111 or 33-131.

33-225 Quantum Physics and Structure of Matter
Fall: 9 units
This course introduces the basic theory used to describe the microscopic world of electrons, atoms, and photons. The duality between wave-like and particle-like phenomena is introduced along with the deBroglie relations which link them. We develop a wave description appropriate for quanta which are partially localized and discuss the interpretation of these wavefunctions. The wave equation of quantum mechanics is developed and applied to the hydrogen atom from which we extrapolate the structure of the Periodic Table. Other materials-related applications are developed, for example, Boltzmann and quantum statistics and properties of electrons in crystals. This course is intended primarily for non-physics majors who have not taken 33-211.
Prerequisites: 33-107 or 33-112 or 33-132.

33-226 Electronics I
Spring: 10 units
An introductory laboratory and lecture course with emphasis on elementary circuit analysis, design, and testing. We start by introducing basic circuit elements and study the responses of combinations to DC and AC excitations. We then take up transistors and learn about biasing and the behavior of amplifier circuits. The many uses of operational amplifiers are examined and analyzed; general features of feedback systems are introduced in this context. Complex functions are used to analyze all of the above linear systems. Finally, we examine and build some simple digital integrated circuits.
Prerequisites: 33-107 or 33-112 or 33-132.

33-231 Physical Analysis
Fall: 10 units
This course aims to develop analytical skills and mathematical modeling skills across a broad spectrum of physical phenomena, stressing analogies in behavior of a wide variety of systems. Specific topics include dimensional analysis and scaling in physical phenomena, exponential growth and decay, the harmonic oscillator with damping and driving forces, linear approximations of nonlinear systems, coupled oscillators, and wave motion. Necessary mathematical techniques, including differential equations, complex exponential functions, matrix algebra, and elementary Fourier series, are introduced as needed.
Prerequisites: 21-122 and (33-112 or 33-132 or 33-107).

33-232 Mathematical Methods of Physics
Spring: 10 units
This course introduces, in the context of physical systems, a variety of mathematical tools and techniques that will be needed for later courses in the physics curriculum. Topics will include, linear algebra, vector calculus with physical application, Fourier series and integrals, partial differential equations and boundary value problems. The techniques taught here are useful in more advanced courses such as Physical Mechanics, Electricity and Magnetism, and Advanced Quantum Physics.
Prerequisite: 33-231.

33-234 Quantum Physics
Spring: 10 units
An introduction to the fundamental principles and applications of quantum physics. A brief review of the experimental basis for quantization motivates the development of the Schrodinger wave equation. Several unbound and bound problems are treated in one dimension. The one electron atom is then treated. Properties of indistinguishable particles are developed allowing an understanding of the structure of the Periodic Table of elements. A variety of mathematical tools are introduced as needed.
Prerequisite: 33-211.

33-241 Introduction to Computational Physics
Fall: 9 units
The course emphasizes the formulation of physical problems for machine computation with exploration of alternative numerical methods. Work will be done on a range of computers from workstations to high performance computing platforms. Examples are drawn from Physics I and II, and Experimental Physics, as well as concurrent physics courses.
Prerequisites: 15-110 and 21-122 and 33-104 and (33-112 or 33-132 or 33-107).

33-301 Physics Upperclass Colloquium I
Fall: 1 unit
Upperclass Physics majors meet together for 1 hour a week to hear discussions on current physics research from faculty, undergraduate and graduate students, and outside speakers. Other topics of interest such as application to graduate school, areas of industrial research and job opportunities are also be presented.
33-302 Physics Upperclass Colloquium II
Spring: 1 unit
Continuation of 33-301.

33-331 Physical Mechanics I
Fall: 10 units
Fundamental concepts of classical mechanics. Conservation laws, momentum, energy, angular momentum, Lagrange’s and Hamilton’s equations, motion under a central force, scattering, cross section, and systems of particles. Prerequisites: 21-259 and 33-232.

33-332 Physical Mechanics II
Spring: 10 units
This is the second semester of a two-semester course on classical mechanics. The course will use the tools developed in 33-331 to examine motion in non-inertial reference frames; in particular, rotating frames. This then leads to the development of general rigid body motion, Euler’s Equations. Finally, the course will cover coupled oscillations with particular emphasis on normal modes. Prerequisite: 33-331.

33-338 Intermediate Electricity and Magnetism I
Fall: 10 units
This course focuses on electro- and magnetodynamics. Topics include Faraday’s Law of induction, electromagnetic field momentum and energy, Maxwell’s equations and electromagnetic waves including plane waves, waves in non-conducting and conducting media, reflection and refraction of waves, and guided waves. Electromagnetic radiation theory includes generation and characteristics of electric and magnetic dipole radiation. The Special Theory of Relativity is applied to electrodynamics: electric and magnetic fields in different reference frames, Lorentz transformations, four-vectors, invariants, and applications to particle mechanics. Prerequisite: 33-338.

33-339 Intermediate Electricity and Magnetism II
Spring: 10 units
This course focuses on electro- and magnetodynamics. Topics include Faraday’s Law of induction, electromagnetic field momentum and energy, Maxwell’s equations and electromagnetic waves including plane waves, waves in non-conducting and conducting media, reflection and refraction of waves, and guided waves. Electromagnetic radiation theory includes generation and characteristics of electric and magnetic dipole radiation. The Special Theory of Relativity is applied to electrodynamics: electric and magnetic fields in different reference frames, Lorentz transformations, four-vectors, invariants, and applications to particle mechanics. Prerequisite: 33-338.

33-340 Modern Physics Laboratory
Spring: 10 units
Emphasis is on hands-on experience observing important physical phenomena in the lab, advancing the student’s experimental skills, developing sophisticated data analysis techniques, writing thorough reports, and improving verbal communication through several oral progress reports given during the semester and a comprehensive oral report on one experiment. Students perform three experiments which are drawn from the areas of atomic, condensed matter, classical, and nuclear and particle physics. Those currently available are the following: Zeeman effect, light scattering, optical pumping, thermal lensing, Raman scattering, chaos, magnetic susceptibility, nuclear magnetic resonance, electron spin resonance, X-ray diffraction, Mössbauer effect, neutron activation of radioactive nuclides, Compton scattering, and cosmic ray muons. Prerequisites: 33-234 and (33-331 or 33-338 or 33-341).

33-341 Thermal Physics I
Fall: 10 units
The three laws of classical thermodynamics, which deal with the existence of state functions for energy and entropy and the entropy at the absolute zero of temperature, are developed along phenomenological lines. Elementary statistical mechanics is then introduced via the canonical ensemble to understand the interpretation of entropy in terms of probability and to calculate some thermodynamic quantities from simple models. These laws are applied to deduce relationships among heat capacities and other measurable quantities and then are generalized to open systems and their various auxiliary thermodynamic potentials; transformations between potentials are developed. Criteria for equilibrium of multicomponent systems are developed and applied to phase transformations and chemical reactions. Models of solutions are obtained by using statistical mechanics and are applied to deduce simple phase diagrams for ideal and regular solutions. The concept of thermodynamic stability is then introduced and illustrated in the context of phase transformations. Prerequisites: 33-232 and 33-234.

33-342 Thermal Physics II
Spring: 10 units
This course begins with a more systematic development of formal probability theory, with emphasis on generating functions, probability density functions and asymptotic approximations. Examples are taken from games of chance, geometric probabilities and radioactive decay. The connections between the ensembles of statistical mechanics (microcanonical, canonical and grand canonical) with the various thermodynamic potentials is developed for single component and multicomponent systems. Fermi-Dirac and Bose-Einstein statistics are reviewed. These principles are then applied to applications such as electronic specific heats, Einstein condensation, chemical reactions, phase transformations, mean field theories, binary phase diagrams, paramagnetism, ferromagnetism, defects, semiconductors and fluctuation phenomena. Prerequisite: 33-341.

33-350 Undergraduate Research
Fall and Spring
The student undertakes a project of interest under the supervision of a faculty member. May include research done in a research lab, extending the capabilities of a teaching lab, or a theoretical or computational physics project. The student experiences the less structured atmosphere of a research program where there is much room for independent initiative. A list of research projects is available. The student must contact the Assistant Head for the Undergraduate Affairs before registering so that student project pairings can be set. Reports on results are required at end of semester.

33-353 Intermediate Optics
Fall: 12 units

33-355 Nanoscience and Nanotechnology
Fall: 9 units
Offered alternative years. This course will explore the underlying science behind nanotechnology, the tools used to create and characterize nanostructures, and potential applications of such devices. Material will be presented on a level intended for upper-level science and engineering students. The course will start with a brief review of the physical principles of electric fields and forces, the nature of chemical bonds, the interaction of light with matter, and elastic deformation of solids. Characterization using electron microscopy, scanning probe methods, and spectroscopic techniques will then be described in detail. Fabrication using top-down and bottom-up methods will be discussed, contrasting these approaches and providing examples of each. Nanotechnology methods will be compared with those used in the modern micro-electronics industry. Finally, examples of nanoscale components and systems will be described, including quantum dots, self-assembled monolayers, molecular computing, and others. Stand-alone laboratory exercises will be included as an important element of the course. These will focus on the use of scanning probe methods to study the nm-scale structure and atomic forces involved in various nanosstructures. Students will sign up for these laboratory sessions and perform the exercises under the supervision of a teaching assistant. In addition to the prerequisites, students should have taken a prior laboratory course in a science or engineering department and should have some familiarity with differential equations at an elementary level. Prerequisites: 33-107 or 33-112 or 33-132.

33-398 Special Topics
9 units
Prerequisites: (33-231 or 21-260) and (21-341).
33-411 Introduction to BioPhysics
Fall: 10 units
This intermediate level course is primarily offered to Physics and Biology undergrads (junior/senior) and provides a modern view of molecular and cellular biology as seen from the perspective of physics, and quantified through the analytical tools of physics. This course will not review experimental biophysical techniques (which are covered, e.g., in 33-871). Rather, physicists will learn what sets "bio" apart from the remainder of the Physics world: how the apparent randomness of life represents to classical thermodynamics is reconciled. They also will learn the nomenclature used in molecular biology. In turn, biologists will obtain a (glimpse of) what quantitative tools can achieve beyond the mere collecting and archiving of facts in a universe of observations. By devising models, non-obvious quantitative predictions are derived which can be experimentally tested and may lead to threads that connect vastly different, apparently unrelated phenomena. One major goal is then to merge the two areas, physics an biology, in a unified perspective.
Prerequisites: 03-121 and (33-107 or 33-112 or 33-132).

33-444 Introduction to Nuclear and Particle Physics
Spring: 9 units
Description of our understanding of nuclei, elementary particles, and quarks, with equal emphasis on the nuclear and particle aspects of sub-atomic matter. We discuss the physics of accelerators, and how particle interactions with matter lead to various kinds of detector instrumentation. Then we discuss methods for measuring sub-atomic structure, symmetries and conservation laws, and the electromagnetic, weak, and strong interactions. We examine the quark model of the mesons and baryons, as well as several models of the atomic nucleus.
Prerequisites: 33-234 and 33-338.

33-445 Adv Quantum Physics I
Fall: 9 units
Mathematics of quantum theory, linear algebra and Hilbert spaces; review of classical mechanics; problems with classical mechanics; postulates of quantum theory; one dimensional applications; the harmonic oscillator; uncertainty relations; systems with N degrees of freedom, multi-particle states, identical particles; approximation methods.
Prerequisite: 33-234
Corequisite: 33-331.

33-446 Advanced Quantum Physics II
Spring: 9 units
Crystal symmetries; quantum symmetries; rotations and angular momentum; spin; addition of angular momentum; the hydrogen atom; quantum “paradoxes” and Bell’s theorem; applications.
Prerequisite: 33-445.

33-448 Introduction to Solid State Physics
Fall: 9 units
This course gives a quantitative description of crystal lattices, common crystal structures observed by adding a basis of atoms to the lattice, and the definition and properties of the reciprocal lattice. Diffraction measurements are studied as tools to quantify crystal lattices, including Bragg’s law and structure factors. Diffraction from amorphous substances and liquids is also introduced. The various types of atomic bonding, e.g., Van der Waals, metallic, ionic, covalent and hydrogen are surveyed. Binding energies of some crystalline structures are calculated. Models of crystal binding are generalized to include dynamics, first for classical lattice vibrations and then for quantized lattice vibrations known as phonons. These concepts are used to calculate the heat capacities of insulating crystals, to introduce the concept of density of states, and to discuss phonon scattering. The band theory of solids is developed, starting with the free electron model of a metal and culminating with the properties of conductors and semiconductors. Magnetic phenomena such as paramagnetism and the mean field theory of ferromagnetism are covered to the extent that time permits.
Prerequisites: (33-234 or 33-225) and 33-341.

33-451 Senior Research
Fall and Spring
Open to all senior physics majors. May include research done in a research lab, extending the capabilities of a teaching lab, or a theoretical or computational physics project. The student experiences the less structured atmosphere of a research program where there is much room for independent initiative. Modern Physics Laboratory, 33-340, should be taken in this course, though it is not required. A list of research projects is available. The student must contact a faculty member and/or the Assistant Head for the Undergraduate Affairs before registering so that student project pairings can be set. Reports on results are required at end of semester.

33-456 Advanced Computational Physics
Spring: 9 units
This course emphasizes application of practical numerical techniques to the types of problems that are encountered by practicing physicists. The student will be expected to understand the principles behind numerical methods such as SVD decomposition, chi-squared minimization, and Fast Fourier Transforms and Monte Carlo simulation of experiments. Applications will include data analysis and eigenvalue problems. Emphasis will be placed on the ability to implement complex algorithms accurately by devising methods of checking results and debugging code. The students will be expected to become proficient in Fortran or C programming.
Prerequisite: 33-241.

33-466 Extragalactic Astrophysics and Cosmology
Spring: 9 units
Starting from the expanding universe of galaxies, this course lays out the structure of the universe from the Local Group of galaxies to the largest structures observed. The observational pinnacle of the Big Bang theory, the microwave background radiation, is shown to provide us with many clues to conditions in the early universe and to the parameters which control the expansion and fate of the universe. Current theories for the development of galaxies and clusters of galaxies are outlined in terms of our current understanding of dark matter. Observational cosmology continues to enjoy a golden era of discovery and the latest observational results will be interpreted in terms of the basic cosmological parameters.
Prerequisites: 33-224 and 33-234.

33-467 Astrophysics of Stars and the Galaxy
Fall: 9 units
The physics of stars is introduced from first principles, leading from star formation to nuclear fusion to late stellar evolution and the end points of stars: white dwarfs, neutron stars and black holes. The theory of stellar structure and evolution is elegant and impressively powerful, bringing together all branches of physics to predict the life cycles of the stars. The basic physical processes in the interstellar medium will also be described, and the role of multi-wavelength astronomy will be used to illustrate our understanding of the structure of the Milky Way Galaxy, from the massive black hole at the center to the halo of dark matter which encompasses it.
Prerequisites: 33-224 and 33-234
Corequisite: 33-341.

33-499 Supervised Reading
Fall and Spring
The student explores a certain area of advanced physics under the supervision of a faculty member. The student must contact a faculty member and the Assistant Head for Undergraduate Affairs before registering.

33-650 General Relativity
Fall: 9 units
General Relativity is the classical theory of gravity. It is widely recognized as a powerful tool - equating gravity and the geometry of spacetime leads to a profound conceptual change in the way we regard the universe. The predictions of the theory are relevant to systems as varied as high precision measurements of the earth’s gravitational field or the strongly curved space-times around black holes. In this course, we will gradually develop an understanding of the geometries which are the solutions of the Einstein equation, with an emphasis on their relevance to physical situations. We will motivate the theory step by step and eventually introduce the Einstein equation itself. Typical Textbook(s): "Gravity, An Introduction to Einstein's General Relativity" by James Hartle.
Prerequisites: 33-211 and 33-339.

33-658 Quantum Computation and Quantum Information Theory
Spring: 10 units
This course, taught in collaboration with the Computer Science Department, provides an overview of recent developments in quantum computation and quantum information theory. The topics include: an introduction to quantum mechanics, quantum channels, both ideal and noisy, quantum cryptography, an introduction to computational complexity, Shor’s factorization algorithm, Grover’s search algorithm, and proposals for the physical realization of quantum devices, such as correlated photons, ions in traps, and nuclear magnetic resonance. The course includes a weekly seminar. Typical Textbook(s): "Quantum Computation and Quantum Information" by Nielsen and Chuang.

33-755 Quantum Mechanics I
Fall: 12 units
This course introduces fundamental concepts of quantum mechanics. Applications are made to quantum computing, the harmonic oscillator, the hydrogen atom, electron spin and addition of angular momentum. 3hrs. lecture. Typical Text: Cohen-Tannoudji Quantum Mechanics, volume 1.
Prerequisite: 33-759.
33-756 Quantum Mechanics II  
Spring: 12 units  
This course focuses on qualitative and approximation methods in quantum mechanics, including time-independent and time-dependent perturbation theory, scattering and semiclassical methods. Applications are made to atomic, molecular and solid matter. Systems of identical particles are treated including many electron atoms and the Fermi gas. Prerequisite: 33-755, Quantum Mechanics I; 33-759 Theoretical Physics. 3 hrs. lecture. Typical Text: Cohen-Tannoudji Quantum Mechanics, volume 2.

33-758 Quantum Computation and Quantum Information Theory  
Spring: 12 units  
This course, taught in collaboration with the Computer Science Department, provides an overview of recent developments in quantum computation and quantum information theory. The topics include: an introduction to quantum mechanics, quantum channels, both ideal and noisy, quantum cryptography, an introduction to computational complexity, Shor's factorization algorithm, Grover's search algorithm, and proposals for the physical realization of quantum devices, such as correlated photons, ions in traps, and nuclear magnetic resonance. The textbook is Nielsen and Chuang, Quantum Computation and Quantum Information, 3 hrs. lecture plus weekly seminar. A 10 unit version of the course, 33-658, does not include the seminar.

33-759 Introduction to Mathematical Physics I  
Fall: 12 units  
This course is an introduction to methods of mathematical analysis used in solving physical problems. Emphasis is placed both upon the generality of the methods, through a variety of sample problems, and upon their underlying principles. Topics normally covered include matrix algebra (normal modes, diagonalization, symmetry properties), complex variables and analytic functions, differential equations (Laplace’s equation and separation of variables, special functions and their analytic properties), orthogonal systems of functions. 3 hrs. lecture and recitation. Typical Text: G. Arfken, Mathematical Methods for Physicists.

33-761 Classical Electrodynamics I  
Fall: 12 units  
This course deals with the static and dynamic properties of the electromagnetic field as described by Maxwell’s equations. Among the topics emphasized are solutions of Laplace’s, Poisson’s and wave equations, effects of boundaries, Green’s functions, multipole expansions, emission and propagation of electromagnetic radiation and the response of dielectrics, metals, magnetizable bodies to fields. 3 hrs. lecture. Typical Text: Jackson, Classical Electrodynamics, 2nd Ed.

33-762 Classical Electrodynamics II  
Spring: 12 units  
The applications of electromagnetic theory to various physical systems is the main emphasis of this course. The topics discussed include the theory of wave guides, scattering of electromagnetic waves, index of refraction, special relativity and foundation of optics. 3 hrs. lecture. Typical Text: Jackson, Classical Electrodynamics. 2nd Ed.

33-765 Statistical Mechanics  
Spring: 12 units  
This course develops the methods of statistical mechanics and uses them to calculate observable properties of systems in thermodynamic equilibrium. Topics treated include the principles of classical thermodynamics, canonical and grand canonical ensembles for classical and quantum mechanical systems, partition functions and statistical thermodynamics, fluctuations, ideal gases of quanta, atoms and polyatomic molecules, degeneracy of Fermi and Bose gases, chemical equilibrium, ideal paramagnetics and introduction to simple interacting systems. 3 hrs. lecture, 1 hr. recitation. Typical Texts: Reif, Statistical and Thermal Physics; Pathria, Statistical Mechanics.

33-767 Biophysics: From Basic Concepts to Current Research  
Spring: 12 units  
Biological Physics aims to apply the principles of physics and the methods of mathematical analysis and computer modeling to understand how biological systems work. This course serves as an introduction into this discipline, suitable as a one-semester course for students not necessarily specializing in this area. It will both provide the necessary general concepts, as well as follow some selected topics up to the current frontier of research. Prerequisite: 33-765 or permission of instructor. Typical text: P. Nelson, Biological Physics, as well as selected original papers.

33-769 Quantum Mechanics III: Many Body and Relativistic Systems  
Fall: 12 units  
The first main theme of this course is quantum mechanics applied to selected many-body problems in atomic, nuclear and condensed matter physics. The second main theme is relativistic quantum mechanics. Creation and annihilation operators are introduced and used to discuss Hartree-Fock theory as well as electromagnetic radiation. The Dirac equation is introduced and applied to the hydrogen atom. Prerequisite: 33-756, 33-761. 3 hrs. lecture.

33-770 Field Theory I  
Fall: 12 units  
This course gives systematic studies of the relativistic field theories. Topics included are canonical quantization of fields, LSZ reduction formula, Feynman diagram techniques, application to quantum electrodynamics and the discussion of the methods of renormalization. Prerequisite: 33-769. 3 hrs. lecture.

33-771 Field Theory II  
All Semesters: 12 units

33-777 Introductory Astrophysics  
Fall: 12 units  
Introductory Astrophysics will explore the applications of physics to the following areas: (i) celestial mechanics and dynamics, (ii) the physics of solar system objects, (iii) the structure, formation and evolution of stars and galaxies, (iv) the large scale structure of the universe of galaxies, (v) cosmology: the origin, evolution and fate of the universe.

33-779 Introduction to Nuclear and Particle Physics  
Fall: 12 units  
An introduction to the physics of atomic nuclei and elementary particles. This course is suitable as a one-semester course for students not specializing in this area and also provides an introduction to further work in 33-780, 33-781. Topics included are symmetry principles of strong and weak interactions, quark model, classification of particles and nuclear forces. Prerequisite: 33-769 (or con-currently). 3 hrs. lecture. Typical Text: Perkins, Introduction to High Energy Physics, plus notes and reading.

33-780 Nuclear and Particle Physics II  
Spring: 12 units  
This course covers the phenomenology of weak interactions, parton model for the deep inelastic scattering, and introduction to gauge theories of weak and electromagnetic interactions. Various topics of current interest in particle physics will also be included. Prerequisite: 33-779, 33-770 (or concurrently). 3 hrs. lecture.

33-783 Solid State Physics  
Fall: 12 units  
This course is designed to give advanced graduate students a fundamental knowledge of the microscopic properties of solids in terms of molecular and atomic theory, crystal structures, x-ray diffraction of crystals and crys, defects, lattice vibration and thermal properties of crystals; free-electron model, energy bands, electrical conduction and magnetism. Prerequisite: 33-756. 3 hrs. lecture. Typical Text: Ashcroft and Mermin, Solid State Physics. Prerequisite: 33-756.

Psychology Courses

85-102 Introduction to Psychology  
Fall and Summer: 9 units  
This course examines major areas of scientific psychology in some depth, the attempt being to develop basic models of our behavior and thought that explain wide areas of our functioning. The primary focus is on the areas of neural and motivational control of behavior, memory and thought, social interaction, and psychological development. Specific topics within these areas include brain function, motivational control systems, learning, cognitive and perceptual information processing, problem solving, obedience and conformity, social interaction, emotion, attitude consistency and change, how our social, cognitive and language functions develop, the importance of childhood to adult functioning, and psychopathology. In addition to the lecture, the course includes a weekly recitation section meeting and weekly short WEB-based laboratory experiences in which students get to perform actual experiments, interpret real data, and experience many psychological phenomena.

85-211 Cognitive Psychology  
Fall and Spring: 9 units  
How do people perceive, learn, remember, and think? This course will consider perception, language, attention, learning, memory, reasoning, and decision making. Experimental findings and formal models will be discussed in each part of the course.
85-213 Human Information Processing and Artificial Intelligence
Fall: 9 units
This class will review various results in cognitive psychology (attention, perception, memory, problem solving, language) and use of artificial intelligence techniques to simulate cognitive processes.
Prerequisite: 15-211.

85-219 Biological Foundations of Behavior
Fall: 9 units
This course will provide students with a general introduction to the underlying biological principles and mechanisms which give rise to complex human cognitive, perceptual and emotional behavior. Topics to be covered include: the anatomical and functional structure of nerve cells and how they communicate, properties of brain organization and function, processing in sensory and motor systems, biological characteristics of human cognition, and neural and hormonal influences on health and emotion. This course will focus on how emerging methods and approaches are beginning to make it possible for psychologists, computer scientists, and biologists to gain an integrated understanding of complex behavior.

85-221 Principles of Child Development
Fall and Spring: 9 units
This course is about normal development from conception through adolescence. Topics include physical, perceptual, cognitive, emotional and social development. Students will learn facts about children at various points in development, theories about how development works, and research methods for studying development in infants and children.
Students will be encouraged to relate the facts, theories and methods of developmental psychology to everyday problems, social issues and real world concerns.

85-241 Social Psychology
Fall and Spring: 9 units
The focus of this course will be on how peoples behavior, feelings and thoughts are influenced or determined by their social environment. The course will begin with lectures and readings on how social psychologists go about studying social behavior. Next, various topics on which social psychologists have done research will be covered. These topics will include: person perception, prejudice and discrimination, the nature of attitudes and how attitudes are formed and changed, interpersonal attraction, conformity, compliance, altruism, aggression, group behavior, and applications of psychology to problems in health care, law, politics, and the environment. Through readings and lectures on these topics, students will also be exposed to social psychological theories.

85-251 Personality
Intermittent: 9 units
The primary purpose of personality psychology is to understand human uniqueness—how and why it is that one person differs from others, in terms of the ways he or she thinks, feels, and acts. Students in the course will be exposed to several broad theoretical perspectives, each of which attempts to capture and understand the origins and consequences of individual distinctiveness from a slightly different vantage point. Included among these approaches are the dispositional, psychoanalytic, learning, phenomenological, and cognitive self regulation perspectives. This is a survey course and is intended to provide students with a broad background of theory and research in the area. Class meetings consist primarily of lecture, but there is some discussion too. In addition, classroom exercises will allow students to test their own personalities.

85-261 Abnormal Psychology
Fall and Spring: 9 units
The study of psychopathology is not an exact science; nor are there many clear-cut parameters with which to differentiate “normal” and “abnormal” behavior. This course will focus on learning about and understanding the range of behaviors which fall within the province of “abnormal” psychology. Its approach will be descriptive, empirical, theoretical and conceptual. Students will examine definitions of abnormality? in an historical and contemporary context, explore issues relevant to diagnosis and patient care, be introduced to various psychological diagnostic categories, and develop an appreciation of the range of treatments for these disorders.

85-281 Introduction to Clinical Psychology
All Semesters: 9 units
This course is designed to introduce students to a wide variety of concepts in the area of clinical psychology. We will explore clinical psychology in an historical perspective, ethics related to the practice of psychology, and various theories of psychotherapy (including psychoanalytic, psychodynamic, existential, and cognitive behavioral). Also, we will look at group theories underlying group therapy and family/systems therapy.
Prerequisites: 85-251 or 85-261.

85-310 Research Methods in Cognitive Psychology
Fall and Spring: 9 units
This is a course in which students develop the research skills associated with cognitive psychology and cognitive science. Students learn how to design and conduct experiments, and analyze and interpret the data they collect. The course covers a variety of experimental designs, e.g., factorial, Latin Squares. Analyses of response times, qualitative data, and signal detection are also covered. Cognitive modeling will also be discussed. Topics include mental imagery, memory, and perception. The class format consists of lectures, discussions and student presentations. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq.
Prerequisites: 85-211 or 85-213
Corequisite: 36-309.

85-320 Research Methods in Developmental Psychology
Fall and Spring: 9 units
This is a laboratory course, in which the student will have direct experience working with children, as well as writing research reports and designing and critiquing research in child development. The purpose of the course is to develop research expertise that will assist the student both in carrying out research and in evaluating the research of others. Special emphasis will be given to the unique methodological problems associated with the study of development. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq.
Prerequisite: 85-221
Corequisite: 36-309.

85-340 Research Methods in Social Psychology
Fall and Spring: 9 units
This course is designed to provide students with the necessary knowledge to evaluate research, make transitions between theory and the operations that test the theory, and to design and carry out original research. Topics will include the nature of proof and causal inference, manipulation of independent variables, measurement of dependent variables, questionnaire design, experimental and quasi-experimental, design and ethical issues involved in doing research. Survey, observational and experimental techniques as applied in both field and laboratory settings will be covered. Students will be expected to critique completed research. They are also expected to design measures and complete their own original studies. During the course of the semester students will also be expected to design and carry out an original research project as well. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq.
Prerequisites: 85-241 or 85-251
Corequisite: 36-309.

85-341 Organizational Communication
Spring: 9 units
Much of the work in groups and organizations consists of communication. You communicate to get information that will be the basis of decisions, to provide a vision for the people who work for and with you, to coordinate activity, and to sell yourself and your work. The goal of this course is to identify sources of communication problems within an organization and ways to overcome them. To do this requires that we know how communication normally works, what parts are difficult, and how to fix it when it goes wrong. The focus of this course is on providing you with a broad understanding of the way communication operates within dyads, work groups, and organizations. This course is not a practicum in public speaking or writing, although you will get some experience writing, speaking, and managing impressions. Rather the intent is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from both the research and the managerial literatures. Among the topics considered are managerial communication, persuasion and conformity, self presentation and person perception, social networks. Cases and group projects give you an opportunity to apply what you’ve learned.
Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.
85-352 Evolutionary Psychology
Intermittent: 9 units
This course will cover both the fundamentals of evolutionary psychology, including the theories of natural and sexual selection, with the overarching aim of providing an overview of the field at an advanced level. We will examine the relevance of evolutionary thinking to a range of psychological phenomena including problems of survival, long-term mating strategies, short-term sexual strategies, parenting, kinship, cooperative alliances, aggression and warfare, conflict between the sexes, and prestige, status, and social dominance. We will also examine evolutionary approaches to sensation and perception, development, consciousness, cognition, language, and abnormal behavior, juniors and Seniors only or permission of instructor. Prereq: 85-102 or 85-211. Prerequisites: 85-241 or 85-251.

85-354 Infant Language Development
Intermittent: 9 units
While adults struggle to learn languages, almost all infants acquire language with seemingly little effort. This course examines infants’ learning abilities and language milestones with a focus on several different theoretical accounts of language development, and the way empirical data can be used to assess those theories. The course is reading intensive, and evaluation will be based on both written assignments and oral participation. Prerequisite: 85-221.

85-355 Introduction to Cognitive Neuroscience
Intermittent: 9 units
Cognitive neuroscience is an emerging interdisciplinary field in which psychological, physiological, and computational methodologies are brought to bear in understanding the neural basis of cognitive processes. In this course, we will consider the application of methodologies such as physiological recordings from neurons in awake, behaving animals, functional neuroimaging (PET and fMRI) of normal subjects performing cognitive tasks, behavioral studies of brain-injured patients with selective cognitive deficits, and computational modeling of normal and impaired processing, in understanding cognitive domains such as high-level vision and attention, learning and memory, reading and language, meaning and semantics, and the organization and control of action. In each instance, the emphasis will be on how the application of converging methodologies, particularly those related to brain organization and function, leads to important insights into the nature of cognitive processes that would be difficult to obtain through any one conventional methodology alone. Prerequisites: 85-211 or 85-219.

85-356 Music and Mind: The Cognitive Neuroscience of Sound
Intermittent: 9 units
This course will take a multidisciplinary approach to understand the neural systems that contribute to auditory perception and cognition, using music and speech as domains of inquiry. Students will master topics in acoustics, psychophysics, cognitive psychology, cognitive development, neuropsychology, and neuropsychology. The early part of the course will provide students with a common foundation in acoustics, signal processing, and auditory neuroscience. Later in the semester, the focus will turn to developing analytical skills through critical evaluation of primary-source experimental literature. Hands-on laboratories and homework sets in sound manipulation and experimentation also will constitute a means of learning about auditory cognitive neuroscience. Throughout, the focus will be upon understanding general cognitive and perceptual challenges in perceiving and producing complex sounds like speech and music. Topics may include biological vs. cultural influences, development in infancy, perception versus production, time perception, effects of experience on perceptual processing, comparative studies of animals, attention, development of expertise, effects of brain damage, and emotional expression. Topics will be addressed from the perspective of cognitive neuroscience, in that we will attempt to understand the neural processes that give rise to auditory perception and cognition. Prerequisites: (85-211 or 85-219 or 85-370) and (85-310 or 85-320 or 85-340).

85-358 Pro-Social Behavior
Fall: 9 units
This course is an advanced seminar that focuses on social psychological research involving the examination of pro-social behavior. A heavy emphasis will be placed on classic research on helping (which investigates how, when, and why we help strangers), as well as the wide body of literature on social support (which investigates how we help, and seek help from, those who are closer to us). Research on both help-seeking and help-provision will be covered, as well as the implications of this type of pro-social behavior for relationships and health. The course also will cover research on other types of pro-social behavior such as empathy, altruism, forgiveness, and cooperation. This is an advanced seminar in which you will be expected to read original research articles and chapters on assigned topics and come to class prepared to discuss the material. Readings will consist of theoretical and empirical articles from psychology journals and related sources. Additional course requirements will involve short, weekly writing assignments, student presentations of research articles, and a written research proposal. Over the course of the semester, students will design and carry out a small-scale, original investigation on a topic of interest. Prerequisites: (85-241 or 85-251) and (85-310 or 85-320 or 85-340).

85-362 Applied Developmental Psychology
Intermittent: 9 units
Developmentally appropriate has become a popular label used to describe activities, materials, and environments designed for children. What does it mean to be developmentally appropriate, and how is it determined? Are these activities and materials evaluated for their impact on children’s development or are they simply designed with a superficial interpretation of theoretical positions or empirical findings? How do we decide what theory to apply when designing or evaluating materials, activities, or contexts for children, and are different theories more informative and applicable than others? The purpose of this class is to think deeply about how our theories and research findings have been and could be applied to support and enhance the development of children in a variety of contexts, such as at home, daycare, school, playgrounds, etc. and to evaluate different activities, materials and/or contexts in reference to various theories and empirical findings. The overall purpose of the course is to understand how theory can inform practice and vice versa. Prerequisite: 85-221.

85-363 Attention, Its Development and Disorders
Intermittent: 9 units
This seminar is on attention, its development, and disorders. The seminar will discuss a broad range of topics including: theoretical and practical implications of studying attention (for example, is it really dangerous to talk on the cell phone while driving? does listening to music help studying?); interrelationship of attention with other cognitive processes, such as perception and memory; challenges and opportunities for studying attention in infants and young children; biological and psychological foundations of attention disorders. Classes will consist of a combination of lecture and discussion. Students will be expected to read original research articles, participate in class discussions, make presentations based on readings, and complete a written assignment. Prerequisites: 85-211 or 85-221.

85-370 Perception
Fall: 9 units
Perception, broadly defined, is the construction of a representation of the external world for purposes of thinking and acting. Although we often think of perception as the processing of inputs to the sense organs, the world conveyed by the senses is ambiguous, and cognitive and sensory systems interact to interpret it. In this course, we will examine the sensory-level mechanisms involved in perception by various sensory modalities, including vision, audition, and touch. We will learn how sensory coding interacts with top-down processing based on context and prior knowledge and how perception changes with learning and development. We will look at methods of psychophysics, neuroscience, and cognitive psychology. The goals include not only imparting basic knowledge about perception but also providing new insights into everyday experiences. Prerequisites: 85-102 or 85-211 or 85-213 or 85-219.
85-375 Crosscultural Psychology
Intermittent: 9 units
This course will examine the relationship between cognition and social processes that are largely unconsciously controlled may be and another is on the interaction of conscious and non-conscious processes in the control of cognition. We will also very broadly examine relevant ideas about consciousness that arise in other fields such as philosophy of mind and physics. The major topics to be included will be drawn from: the experience and functionality of consciousness, neuroscience approaches to consciousness, perceptual and attentional work on consciousness, cognition in altered states of consciousness (in particular, dreaming), implicit memory, and the proceduralization of higher level cognitive processes. The course will consist of our reading and discussing primary research literature from the above areas. There will be a number of short written assignments based on the weekly reading and a term paper.
Prerequisites: 85-211 or 85-213.

85-390 Human Memory
Intermittent: 9 units
Without memory, people would barely be able to function: we could not be able to communicate because we would not be able to remember meanings or words, nor what anyone said to us; we could have no friends because everyone would be a stranger (no memory of meeting anyone); we could have no sense of self because we could not remember anything about ourselves either; we could not predict anything about the future because we would have no recollections of the past; we would not know how to get around, because we would have no knowledge of the environment. This course will discuss issues related to memory at all levels: the sensory registers, i.e., how we perceive things; working or short-term memory; long-term memory or our knowledge base. We will discuss the differences between procedural/skill knowledge, and declarative/fact knowledge. The topics of memory encoding, feeling and knowing, spread of activation within memory (priming), implicit memory, and amnesia will also be covered.

85-392 Human Expertise
Intermittent: 9 units
The process of becoming an expert involves many changes, some quantitative and some qualitative. This course will provide an up-to-date account of the theory and data concerning the development of expertise. Questions addressed include the following. What does it take to become an expert? Are experts born or made? Is the process of acquiring expertise common across different domains from music to sports to science? Research studied in the course will include a variety of methodologies, from case studies to protocol analysis to computational modeling.
Prerequisites: 85-211 or 85-213.

85-395 Applications of Cognitive Science
Spring: 9 units
The famous psychologist George Miller once said that Psychology should “give itself away.” The goal of this course is to look at cases where we have done so—or at least tried. The course focuses on applications that are sufficiently advanced as to have made an impact outside of the research field per se. That impact can take the form of a product, a change in practice, or a legal statute. The application should have a theoretical base, as contrasted, say, with pure measurement research as in economics. Examples of applications are virtual reality (in vision, hearing, and touch), cognitive tutors based on models of cognitive processing, phonologically based reading programs, latent semantic analysis applications to writing assessment, and measures of consumers’ implicit attitudes. The course will use a case-study approach that considers a set of applications in detail, while building a general understanding of what it means to move research into the applied setting.

85-406 Autism: Psychological and Neuroscience Perspectives
Fall: 9 units
Autism is a disorder that affects many cognitive and social processes, sparing some facets of thought while strongly impacting others. This seminar will examine the scientific research that has illuminated the nature of autism, focusing on its cognitive and biological aspects. For example, language, emotion, and theory of mind are affected in autism. The readings will include a few short books and many primary journal articles. The readings will deal primarily with autism in people whose IQ’s are in the normal range (high functioning autism). Seminar members will be expected to regularly engage to class discussions and make presentations based on the readings. The seminar will examine various domains of thinking and various biological underpinnings of brain function, to converge on the most recent scientific consensus on the biological and psychological characterization of autism. There will be a special focus on brain imaging studies of autism, including both structural (MRI) imaging of brain morphology and functional (fMRI and PET) imaging of brain activation during the performance of various tasks.
Prerequisites: 85-211 or 85-213 or 85-219 or 85-355 or 85-429.

85-412 Cognitive Modeling
Spring: 9 units
This course will be concerned with modeling of agent behavior in a range of applications from laboratory experiments on human cognition, high-performance simulations such as flight simulators, and video game environments like Unreal Tournament. The first half of the course will teach a high-level modeling language for simulating human perception, cognition, and action. The second half of the course will be a project in which students develop a simulated agent or agents for the application of their choice.
Prerequisites: 15-122 or 15-150 or 15-251 or 15-210.

85-414 Cognitive Neuropsychology
Spring: 9 units
This course will review what has been learned of the neural bases of cognition through studies of brain-damaged patients as well as newer techniques such as brain stimulation mapping, regional metabolic and blood flow imaging, and attempt to relate these clinical and physiological data to theories of the mind cast in information-processing terms. The course will be organized into units corresponding to the traditionally-defined subfields of cognitive psychology such as perception, memory, and language. In each area, we will ask: To what extent do the neurological phenomena make contact with the available cognitive theories? When they do, what are the implications for those theories (i.e., Can we confirm or disconfirm particular cognitive theories using neurological data)? When they do not, what does this tell us about the parsimony of the mind imposed by the theories and methodologies of cognitive psychology and neuropsychology?
Prerequisites: 85-211 or 85-219.
85-419 Introduction to Parallel Distributed Processing  
Spring: 9 units  
This course will provide an overview of parallel-distributed processing models of aspects of perception, memory, language, knowledge representation, and learning. The course will consist of lectures describing the theory behind the models as well as their implementation, and students will get hands-on experience running existing simulation models on workstations. Prerequisites: 85-211 or 85-213.

85-421 Language and Thought  
Intermittent: 9 units  
This course allows the student to explore ways in which the mind shapes language and language shapes the mind. Why are humans the only species with a full linguistic system? Some of the questions to be explored are: What kinds of mental abilities allow the child to learn language? What are the cognitive abilities needed to support the production and comprehension of sentences in real time? How do these abilities differ between people? Are there universal limits on the ways in which languages differ? Where do these limitations come from cognition in general or the specific language facility? Why is it so hard to learn a second language? Are there important links between language change and cultural change that point to links between language and culture? Prerequisites: 80-150 or 80-180 or 85-211 or 85-213.

85-422 Infancy  
Intermittent: 9 units  
The purpose of this course is to provide students with an extensive background in the field of infant development and to acquaint them with the special methodological and theoretical problems that characterize research in the field. The course will be discussion-oriented and every student will be required to participate actively in both preparing for and contributing to discussion. Specific content areas to be covered include perception, memory, conceptual development, attachment, emotions, social development, and the origins of language. We will cover general readings as well as conflicting empirical studies and theoretical accounts that we will attempt to disentangle and resolve in class discussion. Prerequisite: 85-221.

85-423 Cognitive Development  
Intermittent: 9 units  
The general goals of this course are that students become familiar with the basic phenomena and the leading theories of cognitive development, and that they learn to critically evaluate research in the area. Piagetian and information processing approaches will be discussed and contrasted. The focus will be upon the development of childrens information processing capacity and the effect that differences in capacities have upon the childs ability to interact with the environment in problem solving and learning situations. Prerequisite: 85-221.

85-426 Learning in Humans and Machines  
Spring: 9 units  
This course provides an introduction to probabilistic models of cognition and to developing intelligent machines. The focus is on principles that can help to explain human learning and to develop intelligent machines. Topics discussed will include categorization, causal reasoning, language acquisition, and inductive reasoning. Prerequisites: 15-121 or 15-122.

85-428 Neuro Basis of Cognitive Development  
Intermittent: 9 units  
In this seminar, we will examine the neural basis of cognitive development by linking the functional properties of the developing child, as they are described in Piagetian and neo-Piagetian theories, to the neural systems that support them drawing on the framework provided by computational modeling. The focal issues will be the mapping between functional models and neural models, the normal unfolding of development, the interaction of learning and development, and brain plasticity. The systems to be discussed are (1) language, (2) visuo-spatial processing, (3) learning and attention, (4) complex problem solving, and (5) perceptual-motor functions. The goal of the seminar is to relate and integrate insights from three disciplines: cognitive developmental psychology, neuroscience and computational modeling. The format of the course will be discussions of the readings along with various exercises to explore each component discipline and their interrelation in more detail. For example, some of the exercises involve an introduction to brain imaging, an introduction to computational modeling, and further explorations of psychological experimentation, all within the context of cognitive development. Prerequisites: 85-211 or 85-213 or 85-219 or 85-411 or 85-412 or 85-414 or 85-419 or 85-423 or 85-429.

85-429 Cognitive Brain Imaging  
Spring: 9 units  
This seminar will examine how the brain executes higher level cognitive processes, such as problem-solving, language comprehension, and visual thinking. The topic will be addressed by examining what recent brain imaging studies can tell us about these various kinds of thinking. This new scientific approach has the potential of providing important information about how the brain thinks, indicating not only what parts perform what function, but also how the activity of different parts of the brain are organized to perform some thinking task, and how various neurological diseases (e.g. aphasia, Alzheimer’s) affect brain activity. A variety of different types of thinking will be examined, including short-term working memory storage and computation, problem solving, language comprehension, visual thinking. Several different technologies for measuring brain activity (e.g. PET and functional MRI and also some PET imaging) will be considered, attempting to relate brain physiology to cognitive functioning. The course will examine brain imaging in normal subjects and in people with various kinds of brain damage. Prerequisites: 85-211 or 85-213 or 85-412 or 85-414 or 85-419.

85-442 Health Psychology  
Intermittent: 9 units  
This course is concerned with how behavior and psychological states influence the development of and recovery from disease. The class provides an overview of existing psychological and epidemiological data on the relationship between behavior and disease and addresses the issue of how behavior, emotion and cognition can influence the disease processes. Topics include: measures and concepts, stress and disease, stress and coping, personal control, helplessness and disease, social support and health, reactivity to stress, behavior and hypertension, coronary heart disease, infectious diseases and immune function, and the effectiveness of behavioral interventions in health. Special permission of instructor required.

85-443 Social Factors and Well-Being  
Intermittent: 9 units  
This course will focus on the role that our social environment plays in our feelings of well-being and in the maintenance of our mental and physical health. Topics to be discussed include marriage, widowhood, loneliness, social support, social participation, social aspects of personality (e.g., social anxiety, extraversion, agreeableness, and hostility), social stressors (betrayal and conflict), discrimination, and socioeconomic status. We will consider how each social factor develops, the extent to which we can alter it or its effects on our lives, and how it influences our overall well-being. Instructor permission is required.

85-444 Relationships  
Fall: 9 units  
The primary goal of this course is to introduce you to social psychological theory and research on the topic of relationships. Although a variety of relationship phenomena will be discussed, a heavy emphasis will be placed on research that addresses fundamental processes in close relationships. The coverage of material will include a review of historical roots and classic approaches to the scientific study of relationships, as well as exciting new research and theory on particular subtopics. The majority of class time is spent discussing and evaluating recent research. Special emphasis also is given to learning and critically evaluating the methodological tools that are used to study close relationships. The goal is for students to leave this course with a broad overview of the field and an in-depth understanding of particular subtopics. This is an advanced seminar in which students will be expected to read original research articles and chapters on assigned topics and come to class prepared to discuss the material. Readings will consist of theoretical and empirical articles from psychology journals and related sources. Additional course requirements will involve short, weekly writing assignments, student presentations of research articles, and a written research proposal. Over the course of the semester, students will design and carry out a small-scale, original investigation on a relationships topic of interest. Prerequisites: (85-241 and 85-340) or (85-251 and 85-340).

85-446 Psychology of Gender  
Spring: 9 units  
This course is devoted to the investigation of psychological gender rather than biological sex. That is, sex differences will be explored from a social psychological (e.g., socialization) perspective. Implications of both male gender role and female gender role in the areas of relationships and health will be the course focus. Prerequisites: 85-241 or 85-251.
85-480 Internship in Clinical Psychology
All Semesters
This course introduces students to Clinical Psychology and related mental health fields. Students’ learning is facilitated through classroom-based activities and by learning about clinical research and/or practice in designated field settings. Students spend 3 hours per week in class and 6 hours per week in an applied or research setting. Please contact Dr. Beth Zimick if you are interested in enrolling at bethc@andrew.cmu.edu. Prerequisites: 85-251 or 85-261.

85-482 Internship in Psychology
Fall and Spring
The Internship in Psychology is designed to enable students to gain experience in professional settings related to their studies in Psychology and earn credit for the intellectual work involved. It is the students responsibility to locate an internship site and on-site supervisor, as well as to identify a CMU Faculty Sponsor. The student registers for the internship by submitting a completed internship form to Theresa Kurutz in Baker Hall 343.

85-484 Practicum in Child Development
Fall and Spring: 9 units
This guided field experience is designed to help students deepen their understanding of developmental psychology by assisting in a preschool or kindergarten classroom and discussing the ways that their experiences relate to the theories they have learned previously and to new readings. Each student will individually schedule a consistent 6 hours per week helping in a children’s school classroom (preferably 2 or 3 chunks of time). Classroom duties will include working one-on-one and with small groups of students as they do puzzles, art projects, dramatic play, etc., as well as helping with snack, playground supervision, classroom cleanup, and storytelling. Each student will be expected to keep a journal 1) relating general experiences to developmental theories and 2) documenting the development of a particular child during the semester. All students will meet for 1 hour weekly discussion with the director. Discussion topics and related readings will be selected collaboratively, based on issues/questions raised by the group’s observations and discussions. Prerequisite: 85-221.

85-501 Stress, Coping and Well-Being
Fall
This course will examine basic processes and theory about stress and coping from a psychological perspective. The first part of the course will explore topics related to the psychobiology of stress, stress measurement, and links between stress and health. The second part of the course will explore topics on mechanisms and theoretical perspectives on coping with stress. This will include a consideration of topics such as emotion regulation, self-regulation, coping with traumatic events, alternative medicine approaches, and resilience factors. This class is a small, upper level seminar that will consist of some lecture and extensive class discussion. Active class participation is required. Prerequisites: 85-310 or 85-320 or 85-340.

85-505 Readings In Psychology
All Semesters
As the name implies, the emphasis in the Reading course is on reading articles and books in some specified area. The students work in the course must lead to the production of a written paper which will be read by the instructor directing the readings. Often the reading is related to a research project which the student may wish to conduct. Readings courses have also been used to give students an opportunity to receive instruction in areas which are not included elsewhere in our course listing. The course may be taken for any number of units up to 9, depending upon the amount of work to be done.

85-506 Readings In Psychology
All Semesters
As the name implies, the emphasis in the Reading course is on reading articles and books in some specified area. The students work in the course must lead to the production of a written paper which will be read by the instructor directing the readings. Often the reading is related to a research project which the student may wish to conduct. Readings courses have also been used to give students an opportunity to receive instruction in areas which are not included elsewhere in our course listing. The course may be taken for any number of units up to 9, depending upon the amount of work to be done.

85-507 Research in Psychology
Fall
This course may include field study, applied work, or laboratory research. The student should have previous training in the basic research skills that will be used in his/her project, especially statistical methods and experimental design. Independent Research Projects will be supervised by a faculty member and must result in a written paper. It is the students responsibility to make arrangements for independent study courses with individual faculty members. This should be done the semester before a student wishes to register for one of these courses. The course may be taken for any number of units up to 12, depending upon the amount of work to be done.

85-508 Research in Psychology
Spring
This course may include field study, applied work, or laboratory research. The student should have previous training in the basic research skills that will be used in his/her project, especially statistical methods and experimental design. Independent Research Projects will be supervised by a faculty member and must result in a written paper. It is the students responsibility to make arrangements for independent study courses with individual faculty members. This should be done the semester before a student wishes to register for one of these courses. The course may be taken for any number of units up to 12, depending upon the amount of work to be done.

85-601 Senior Thesis
Fall: 9 units
This course is intended for senior Psychology or Cognitive Science majors who wish to conduct a research project under the direction of a faculty advisor. The project topic is to be selected jointly by the student and the advisor. The project will culminate in a senior paper which will be presented to the Department Head at the end of Fall Semester. Prerequisite: Grade of B or better in a previous research course required to enter, grade of B or better in first semester of senior thesis course required to complete, and permission of instructor. A formal proposal is required in the first semester. This course differs from the Honors Thesis sequence (66-501,502) in that it does not require Honors standing in HSS (i.e., there are no GPA requirements). This course differs from Research in Psychology (85-507,508) in that the student’s original contribution to the research is expected to be more substantial, and in that a final written report of the project is to be presented to the Department.

85-602 Senior Thesis
Spring: 9 units
This course is intended for senior Psychology or Cognitive Science majors who wish to conduct a research project under the direction of a faculty advisor. The project topic is to be selected jointly by the student and the advisor. The project will culminate in a senior paper which will be presented to the Department Head at the end of Fall Semester. Prerequisite: Grade of B or better in a previous research course required to enter, grade of B or better in first semester of senior thesis course required to complete, and permission of instructor. A formal proposal is required in the first semester. This course differs from the Honors Thesis sequence (66-501,502) in that it does not require Honors standing in HSS (i.e., there are no GPA requirements). This course differs from Research in Psychology (85-507,508) in that the student’s original contribution to the research is expected to be more substantial, and in that a final written report of the project is to be presented to the Department.

85-765 Cognitive Neuroscience
Intermittent
This course will cover fundamental findings and approaches in cognitive neuroscience, with the goal of providing a very broad overview of the field at an advanced level. Topics will include high-level vision, spatial cognition, working memory, long-term memory, learning, language, executive control, and emotion. Each topic will be approached from a variety of methodological directions, for example, computational modeling, cognitive assessment in brain-damaged humans, non-invasive brain monitoring in humans, and single-neuron recording in animals. Lectures will alternate with sessions in seminar format. Prerequisites: Graduate standing or two upper-level psychology courses from the areas of developmental psychology, cognitive psychology, computational modeling of intelligence, neuropsychology or neuroscience.
Public Policy Mgt:Sch of Pub Pol Mgt Courses

90-708 Healthcare Ethics
Spring and Summer: 6 units
This course will survey several important ethical issues problems and dilemmas that arise in the context of the delivery of healthcare. It will begin with discussions that focus upon the nature of ethics in general and applied ethics in particular. The goal of this introductory portion of the course will be to establish a healthcare decision making framework that will be used during the remaining sections of the course. Topics introduced here will include: theoretical and applied ethics moral pluralism principalism the differences between absolutism relativism and pluralism and prudential reasoning as a tool of ethical analysis in healthcare. The specific healthcare areas that will be discussed and analyzed from a normative perspective include: determining the beginning and the end of human life the ethical questions surrounding abortion end of life issues such as euthanasia and physician assisted suicide various reproductive issues medical research ethics ethics in the medical treatment of infants and children transplantation issues and the ethics of medical genetics. The course will proceed by means of lectures small and large group discussions and the analysis of well-known essays and case studies in healthcare ethics.

90-718 Strategic Presentation Skills
Fall and Spring: 5 units
In the next seven weeks you will develop a proposal appropriate for your level of experience. This proposal will request support of a policy or organizational procedure relevant to your professional interests. You will work with this material in a variety of ways. Formal presentations include: 1. A first briefing. For this assignment develop a proposal that could be used outside of class in a real-world setting. Identify a likely audience (role-played by class participants) prepare an audience analysis write an outline that supports your <<ask>>& < design visuals that support your argument prepare for questions develop a final statement and deliver your presentation. The total time of the presentation including Q & A is 12 minutes. You will speak extemporaneously well-prepared but without a written script. 2. A motivational speech. For this assignment prepare a formal 5-minute speech for which a manuscript would be expected. The occasion might be a press conference announcement keynote address at an annual meeting or appearance before a legislative body. For this speech decide whether your <<ask>>& < has been granted or denied. If your <<ask>>& < has been granted celebrate the significance of this decision and motivate listeners to continue the work you've begun. If the ask has been denied acknowledge the <<bad news>>& < and motivate listeners to support your idea despite the setback. 3. A revised briefing/final exam. The total time of the briefing including Q & A is 12 minutes. You will speak extemporaneously without a written script.

90-721 Healthcare Management
Fall: 6 units
This course introduces the values knowledge and skills required to strategically manage the rapidly changing internal and external environment of health care organizations. The course is designed to provide students with a solid foundation in contemporary health care management practices. <a href="http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=19">Read More</a>.

90-758 Ethics & Public Policy in a Global Society
Spring: 6 units
The first section of the mini-course will be devoted to a discussion of the nature of ethics and applied ethics. Here a framework useful in the ethical analysis of issues problems and dilemmas in public life will be constructed. The second section of the course will demonstrate the usefulness of this framework in the analysis and evaluation of policy issues from a normative point of view. In this section various arguments concerning the nature of the social ethics that form the background of policy debates also will be a focus in the mini-course. The course will consider: reproductive rights matters end-of-life decisions questions about free speech social and economic justice and environmental considerations.

90-765 Cities, Technology and the Environment
Fall: 6 units
This course will explore the interaction of cities, technology and the natural environment over time. More specifically, it will consider the evolution of several major issues confronting cities today: (1) water supply, wastewater disposal and flooding; (2) Energy and Environment; (3) Transportation, urbanization and land use; and (4) Brownfield creation and development. In a number of instances, the Pittsburgh region will be used to provide examples of these issues. These themes will be approached through a combination of class discussions, lectures, and visiting speakers. Class participation is expected, and will comprise a portion of the grade. Upon completion of this course, the student will be able to: 1. Analyze the interaction of cities, technology and the natural environment over time. 2. Be cognizant of the major issues confronting cities today, (1) water supply, wastewater disposal and flooding; (2) Energy and Environment; (3) Transportation, urbanization and land use; and (4) Brownfield creation and development. 3. Write a thought-paper that explores a relevant problem, discusses its evolution and turning points, and suggests policy options.

90-789 Sustainable Community Development
Spring: 12 units
This course will involve an in-depth examination of the economic and social value that is created when development occurs in a sustainable manner. The various components of comprehensive community development will be defined through class lectures guest speakers and case studies. These components will include: housing business and economic development cultural and social development transportation systems and open spaces. Economic and design comparisons will be drawn between sustainable and non-sustainable models of development. The course will also consider how public policy and private decision-making can be influenced by well-organized community planning and advocacy efforts.

90-798 Environmental Policy & Planning
Fall: 12 units
Environmental Policy and Planning provides an introduction to how environmental policies have been and can be designed/created implemented and evaluated amidst complex information-based social political and cultural processes. The course emphasizes a systems-based methodological approach for addressing the complexities involved in framing analyzing and designing an implementation plan for policy construction. The course also explores through landmark and contemporary case studies several dimensions of environmental policymaking. * Contextual historical and structural aspects of environmental policymaking at the local state federal and international levels * Use of quantitative and qualitative analytical tools (from the course program as well as non-class) * The process of how policies derive their meaning. Students in this course work on a final environmental policy project to demonstrate mastery of the knowledge and skill-based exercises explored during the term.

90-808 Energy Policy
Fall: 6 units
This seminar will provide an introduction to modern U.S. energy policy. What lessons have we learned from past initiatives? How different is our current policy? How much influence does government really have? How does the U.S. interact with other countries? The class will begin with a discussion of the U.S. policy reaction to Arab oil embargoes of the 1970s — which resulted in the creation of the U.S. Energy Department and the first significant attempts to move the country from a dependence on (imported) oil. Besides describing the U.S. government components that play a role in the development and implementation of energy policy we will also analyze many of the relevant policy levers: economics technology politics public opinion and national security. The class will then turn to more recent developments - studying the development and implementation of energy legislation during the last decade. We will also focus on a few case studies — such as the Keystone Pipeline the Cape Wind Project and the development of the Marcellus Shale — that demonstrate conflicting viewpoints about appropriate energy policy. Finally we will conduct a crisis simulation in order to explore the national security implications of a global oil disruption. Each class will begin with a short discussion of current events in the energy sector. There will also be a number of guest lecturers including senior government officials.
90-818 Health Care Quality & Performance Improvement
Spring and Summer: 6 units
This course provides an overview of the current state of the quality movement in Health Care. A public health perspective as well as an individual perspective will be considered from both a U.S. and international view. Relevant history current gurus landmark publications theories tools and environmental factors will be discussed and utilized. We will explore the cost/quality connection and analyze the complex forces that shape under the transformation of health care from the current state to a person centered quality focused Health Care System. <a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=440'>Read More</a>.

90-830 Introduction to Financial Management of Health Care
Fall: 6 units
This course is designed to provide students with a general understanding of health systems financial management. Students will acquire technical expertise and analytical skills to evaluate financial matters encountered in the overall management of health systems (e.g., hospitals, physician practices, integrated delivery systems and nursing homes). Non-financial health care managers should develop practical skills to assess financial implications of future federal/state health policy and budget decisions. Many students find this course to be helpful as background for other health care elective courses. This course will include: Lectures and extensive textbook readings to familiarize students with health systems financial management functions. Historical perspectives will include a macroeconomic overview of health expenditures and the evolution of third-party payors. Detailed review of current payment and reimbursement systems for providers and insurers including Medicare and Medical Assistance. Lectures by guest speakers who will share their experiences in applying financial management theories within various health care situations. Presentation of case studies which provide students an opportunity to apply their skills to practical situations. <a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=116'>Read More</a>.

90-831 Advanced Financial Management of Health Care
Fall: 6 units
The mini-course is designed to provide the students with a practical understanding of the challenges in managing a healthcare facility. Through the use of actual data guest speakers from Children’s management and a major healthcare insurance company students will develop an understanding of the challenges that were faced by the hospital over the past decade. As the sole pediatric facility in the area Children’s experienced positive financial results and little competition until the early 1990’s. This was the result of increased penetration of managed care into the region and insurance companies purchasing physician practices. Children’s responded like many facilities by attempting to cut costs and buy practices in order to protect market share. What occurred is that such actions caused further deterioration in the financial results. Fiscal Year 1997 produced the worst financial results in the hospital’s history causing the Board to take drastic actions. What followed was during a five year period operating results improved by approximately $25 million as a result of changing leadership, going back to business-basics and creating a greater sense of accountability throughout the organization. Although Children’s will be used as a case study the topics discussed are applicable to any healthcare institution. Advance work will include financial statement review and analysis. The on-campus classroom sessions will include guest speakers and discussion of real life challenges experienced at Children’s Hospital over the last 10 years. The principal topic areas of the course are: Financial Statement Analysis Revenue Cycle components Contracting challenges Expense management Physician practice models Nursing challenges Leadership Non-profits accessing Capital <a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=117'>Read More</a>.

90-832 Health Law
Fall: 12 units
This course explores the law related to provision of health care and governing health care institutions. Starting with an examination of the structure of the United States legal system this course then examines some of the statutes regulations and cases whose subjects are the provision of health care services in the US. Topics covered include malpractice patient rights reimbursement research and death and dying. The course requires extensive reading which is provided on Blackboard and which is primarily composed of original sources such as Supreme Court cases and federal and state statutes and regulations. There is an optional take-home midterm and a required take-home final. <a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=118'>Read More</a>.

90-836 Health Systems
Fall: 6 units
This is a 6-unit course designed to provide students with an introduction to the structure operation and functioning of health care systems. It is a core course for students in the Master of Science of Health Care Policy and Management (HCMP) program and is a prerequisite for most of the courses in the program that follow. This course provides a broad overview of the multiple systems that define describe and shape health care systems with a particular emphasis on the U.S. health care system. The learning objectives of this course are to: - Gain factual knowledge of the broad elements and overall principles of U.S. Health Care System - Develop an understanding of the dynamics of health care systems involving interaction of patients health care providers sources of health care financing insurance and regulatory and quasi- regulatory organizations. - Understand the key external forces that influence health services including social economic political demographic and epidemiological factors. - Describe significant components of the U.S. health care system discuss the interaction among elements of the health system review the ongoing development of health services and systems and relate health services to major social and other external forces. - Define and apply health systems terminology - Acquire and enhance skills in gathering and presenting information about health care systems and demonstrate familiarity with major sources of information of health care systems and service delivery.<a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=366'>Read More</a>.

90-861 Health Policy
Fall: 6 units
The aim of this survey course in health policy is to enable students to think systematically about the determinants of health the problems of the health care system and the various strategies available to government for addressing these matters. Our discussions will touch on some broad topics including our expectations of medical care and the appropriate role for government in the health care system. The course emphasizes contemporary topics that are important in the health policy debates of virtually all industrialized nations and provides cross-national comparisons of these health care systems. At the end of the course students will be able to describe the health care systems of most industrialized nations and compare and contrast these systems with the current health care system in the United States. <a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=140'>Read More</a>.

90-863 Health Policy I
Spring: 6 units
This course teaches how to conduct policy analysis in the area of health care. Students will learn how to identify a problem clearly evaluate alternative proposals and their potential impacts and communicate effectively with policymakers. We will build on the institutional background and conceptual frameworks from the Health Systems and Health Policy I courses. Here students will focus on a particular policy issue and will produce a detailed written analysis and in-class presentation on their topic. To provide examples lectures will cover a range of policy challenges including cost containment retirement-age policy health disparities pharmaceutical safety and innovation and medical malpractice.<a href='http://www.heinz.cmu.edu/academic-resources/course-results/course-details/index.aspx?cid=142'>Read More</a>.

Robotics Courses
16-264 Humanoids
Spring: 12 units
This course surveys perception, cognition, and movement in humans, humanoid robots, and humanoid graphical characters. Application areas include more human-like robots, videogame characters, and interactive movie characters.

16-299 Introduction to Feedback Control Systems
Spring: 12 units
This course is designed as a first course in feedback control systems for computer science majors. Course topics include classical linear control theory (differential equations, Laplace transforms, feedback control), linear state-space methods (controllability/observability, pole placement, LQR), nonlinear systems theory, and an introduction to control using computer learning techniques. Laboratory work includes implementation of controllers robotic devices. Priorities will be given to computer science majors with robotics minor.
Prerequisites: 15-122 and 21-122.
16-311 Introduction to Robotics  
Spring: 12 units  
This course presents an overview of robotics in practice and research with topics including vision, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors. In course projects, students construct robots which are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students nominally work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. This course will also expose students to some of the contemporary happenings in robotics, which includes current robot lab research, applications, robot contests and robots in the news. <P> The current prerequisites for 16-311 are 15-122 and Matrix Algebra.  
Prerequisites: 15-122 and 21-241.

16-362 Mobile Robot Programming Laboratory  
Fall: 12 units  
This course is a comprehensive hands-on introduction to the concepts and basic algorithms needed to make a mobile robot function reliably and effectively. We will work in groups with Nomad Scout robots and interface to them using laptops programmed in the Java programming language in a modern code development environment. This is a lab course with emphasis is on hands-on learning. You will get experience in this course in addition to some theory. Lectures are focussed on the content of the next lab. There is a lab every week and they build on each other so that a complete robot software system results. The course will culminate with a class-wide competition that tests the performance of all of your code implemented in the semester. Typically, your code is at least 5000 lines of Java written jointly with 2 other people. Students must have a 2nd year science/engineering level background in mathematics (matrices, vectors, coordinate systems, basic kinematics) to succeed in the course. Students must have mastered 1 programming course experience) computer programming in a procedure language like C or Java to succeed in the course. The following experience, while not required, will be an asset: a) familiarity with basic computer science data structures and algorithms (equivalent to taking 15-121), b) experience with Eclipse and Subversion or equivalent software development tools, c) experience collaboratively designing and implementing a software system => 5,000 lines of code.

16-384 Robot Kinematics and Dynamics  
Fall: 12 units  
Foundations and principles of robotic manipulation. Topics include computational models of objects and motion, the mechanics of robotic manipulators, the structure of manipulator control systems, planning and programming of robot actions.  
Prerequisites: (15-122) and (18-202 or 24-311 or 21-241).

16-421 Vision Sensors  
Spring: 12 units  
This course covers the fundamentals of vision cameras and other sensors - how they function, how they are built, and how to use them effectively. The course presents a journey through the fascinating five hundred year history of "camera-making" from the early 1500s "camera obscura" through the advent of film and lenses, to today's mirror-based and solid state devices (CCD, CMOS). The course includes a significant hands-on component where students learn how to use the sensors and understand, model and deal with the uncertainty (noise) in their measurements. While the first half of the course deals with conventional "single viewpoint" or "perspective" cameras, the second half of the course covers much more recent "multi-viewpoint" or "multi-perspective" cameras that include a host of lenses and mirrors.  
Prerequisites: 21-111 and 21-241.

16-721 Learning-Based Methods in Vision  
Spring: 12 units  
A graduate seminar course in Computer Vision with emphasis on using large amounts of real data (images, video, textual annotations, user preferences, etc) to learn the structure of our visual world toward the ultimate goal of Image Understanding. We will be reading an eclectic mix of classic and recent papers on topics including: theories of perception, low-level vision (color, texture), mid-level vision (grouping and segmentation), object and scene recognition, image parsing, words and pictures models, image manifolds, etc. Prereq: Graduate Computer Vision, 16-720  
Prerequisite: 16-720.

16-735 Robotic Motion Planning  
Intermittent: 12 units  
The robot motion field and its applications have become incredibly broad and theoretically deep at the same time. The goal of the course is to provide an up-to-date foundation in the motion planning field, make the fundamentals of motion planning accessible to the novice and relate low-level implementation to high-level algorithmic concepts. We cover basic path planning algorithms using potential functions, roadmaps and cellular decompositions. We also look at the recent advances in sensor-based implementation and probabilistic techniques, including sample-based roadmaps, rapidly exploring random trees, Kalman filtering, and Bayesian estimation.

16-741 Mechanics of Manipulation  
Spring: 12 units  
Kinematics, statics, and dynamics of robotic manipulator's interaction with a task, focusing on intelligent use of kinematic constraint, gravity, and frictional forces. Automatic planning based on mechanics. Application examples drawn from manufacturing and other domains.

16-761 Mobile Robots  
Spring: 12 units  
This course covers all aspects of mobile robot systems design and programming from both a theoretical and a practical perspective. The basic subsystems of control, localization, mapping, perception, and planning are presented. For each, the discussion will include relevant methods from applied mathematics, aspects of physics necessary in the construction of mobile robots and environmental behavior, and core algorithms which have proven to be valuable in a wide range of circumstances.

16-778 Mechatronic Design  
Spring: 12 units  
Mechatronics is the synergistic integration of mechanism, electronics, and computer control to achieve a functional system. Because of the emphasis upon integration, this course is a semester-long multidisciplinary capstone hardware project design experience in which small teams of electrical and computer engineering, mechanical engineering and robotics students deliver an end-of-course demonstration of a final integrated prototypical system. Throughout the semester, the students configure, design, implement, test and evaluate in the laboratory several mechatronic devices and subsystems culminating in the final integrated system. Lectures will complement the laboratory experience with comparative surveys, operational principles, and integrated design issues associated with the spectrum of mechanism, electronics, and control components.

16-862 Mobile Robot Programming Laboratory  
Fall: 12 units  
This course is a complete, hands-on introduction to Mobile Robot Programming. Using six Nomad Scout robots and portable computers, we will survey topics ranging from low-level control and obstacle avoidance, including PID control, to high-level navigation, planning, robot-robot communication and cooperation.

Social Decision Sciences Courses

88-104 Decision Processes in American Political Institutions  
Fall: 9 units  
This is an interdisciplinary introduction to the study of politics and government, drawing mostly on political science, but also on economics. It familiarizes the student with the basic structures and processes of American government. The main theoretical tools are spatial models of political decision making, and models of collective action problems. The course focuses on politics and government in the United States, but explicit comparisons are made with politics in other countries. Grading is usually based on two midterm exams and a final exam, as well as a short writing assignment, several quizzes and homework.

88-110 Experiments with Economic Principles  
Fall: 9 units  
This course is designed to teach the basic principles of economics through the use of experiments. In each experiment you will be an active participant attempting to make deals with other traders in the market. At the end of the experiment it is time to really put economics to the test——can economic theory really explain the complex interactions of the participants in your experiment? One nice feature of these experiments is that you can be both a participant and an observer, and you often will learn nearly as much about economic principles from your experience as a participant as you will from the analysis of the experiment as an observer. Topics covered include basic market behavior, auctions, rent control, pollution, network externalities, information economics, and international trade.
88-111 SDS Freshman Seminar: Human Rights and Global Politics
Fall: 9 units
The purpose of the seminar is to study human rights from different dimensions. First, we will examine the meaning of the term and the issues associated with defining the human rights field. What are these rights? What is their origin? Secondly, we will examine which rights/issues have been raised in the contemporary international political system and the responses from major international actors such as the United States, the Western European countries, International Organizations, and the NGO’s such as Amnesty International. The central issue here is one of answers and policies toward human rights abuses/issues. Finally, we will analyze a number of case studies. Some case studies will be presented in the lectures, some will be discussed by the students. Students will be asked to do research and report on a case of human rights abuses looking not only at the issue or conflict that has led to those abuses, but also international responses to the issue.

88-114 SDS Freshman Seminar: Everyday Irrationality
Intermittent: 9 units
This seminar will cover the historical progression from belief in hot irrationality—i.e., emotional interference with an otherwise pristine intellect (Plato, Freud) through cold irrationality—i.e., clear thought stymied by common cognitive biases and heuristics (Tversky and Kahneman)—through a possible integration of hot and cold approaches—e.g., resulting from attentional mechanisms (Simon, Loewenstein, Lerner). Then the professor and students will discuss belief in ESP, alternative medicines, faith healing and Nazism in terms of the principles proposed. During the last half of the semester, students will choose a particular irrational belief to study and will both present to other students and write a term paper describing its acceptance (by at least some people) and possible reasons for such acceptance. The major text will be Dawes’s new book “Everyday Irrationality: How Pseudo-Scientists, Lunatics, and the Rest of Us Systematically Fail to Think Rationally.” This book will be supplemented by selected readings from Plato, Freud, Hines’s book on “Pseudoscience and the Paranormal,” Gilovich’s book of “How We Know What Isn’t So,” a book of first-hand accounts by the perpetrators of the Holocaust entitled “Death Dealers,” and finally Browning’s book of “Ordinary Men.”

88-115 Risk Communications for Health Decisions
This seminar will explore how people make decisions about risk behaviors in various contexts relating to their health, including diet and exercise, sexual behavior, smoking, drinking, drug use, etc. The main focus of the course will be looking at efforts to improve health by educating people to make better decisions about reducing their own health risks. Students will participate in active class discussion, debating benefits of different approaches to public health. The mid-term project will include basic research and data collection on a health behavior. The final project will include the production and planned evaluation of a public service announcement, aimed at improving health decisions and behaviors. Readings will include book chapters and original research articles relating to the psychology behind such behaviors and trade-offs.

88-116 HSS Freshman Seminar: Psychobabble
Intermittent: 9 units
At the beginning of the semester we will go through my annotated dictionary of psychobabble and show videos of psychobabble in “living action”—e.g. recovering repressed memories of being raised in a satanic cult, believing it is possible to communicate with autistic children through “facilitated communication” where they indicate to a skilled therapist what they want to spell out on a keyboard (without looking). Then I will have students volunteer to lead discussions about particular types of psychobabble. Attendance will be required. Evaluation will be on the basis of presentations and a term paper.

88-117 Social Dilemmas from Overpopulation to Global Warming
Spring: 9 units
Social dilemmas are situations in which a number of people make simultaneous choices between what is roughly termed “cooperative” versus “non-cooperative” behavior where the individual payoffs for the non-cooperative choice are always higher than for the non-cooperative choice – no matter what other people involved in the decision do. Yet universal cooperation is preferred to universal non-cooperation by all the people making the choices. The first part of the seminar will be devoted to reading the classic theoretical arguments about social dilemmas, and to the surveying some of the empirical findings of social psychologists such as Dawes about what variables other than payoff changes might enhance the probability of cooperative choices, e.g., “identification with the group”. After becoming familiar with the theoretical and empirical literature, the members of the seminar will be asked to give presentations concerning either their own ideas or the ideas of some other theorist or investigator about how to enhance the incidence of cooperative choice. Each member of the seminar will be expected to lead one session presenting such ideas and to write a term paper about them.

88-119 Strategy Cooperation and Competition
9 units
When should a person cooperate and when should a person be selfish in an ongoing social interaction? How can a business establish strategic partnerships when it comes to creating a pie and at the same time battle competitors when it comes to dividing up the pie? Strategic thinking requires a framework to think through the implications of cooperation and of competition. Game theory is a systematic approach to understanding how people, firms, or countries interact with one another to achieve their own goals. In this course students will learn to apply game theory to analyze strategic situations arising in the business world as well as in politics, sports, and international relations. We will discuss how individuals and businesses can shape the games they play to their benefit and how social policies can be implemented to encourage cooperation benefiting everybody. Readings will focus on real-life stories accompanied by a full analysis of the principles involved. Students will give presentations applying these principles to a strategic problem they find engaging. Students will also be placed in the role of strategist in simulations in class.

88-120 Reason, Passion and Cognition
Spring: 9 units
This course will introduce students to major concepts and theories in the social and decision sciences, focusing in particular on how cognition and emotion shape judgment and choice. We will address such questions as: In what ways do emotions influence judgments and choices? What are some common mistakes in judgment and decision making? Can information shape our choices even if we do not consciously recognize the information? Throughout the course, the emphasis will be on understanding (1) basic theories and research findings of decision science and psychology, and (2) the relevance of research findings to everyday life.

88-181 Topics in Law: 1st Amendment
Fall: 9 units
In their firm desire to perfect the new Constitution, which defined and limited the powers and roles of their new government, the founding fathers insisted on explicit statements that would protect the rights of the new nation’s citizens. Indeed, the protection of these essential rights in many ways drove and defined their successful rebellion from Britain. This impulse resulted in ten amendments to the Constitution, which we have come to know as the Bill of Rights. The very first (and arguably considered at the time as the most essential) of these was the First Amendment, which we sometimes call the “free speech” amendment to the Constitution. This amendment guarantees every U.S. citizen five freedoms: freedom of religion, speech, press, peaceable assembly, and the freedom to petition the government for redress of grievances. This course examines the historical and philosophical roots of this key constitutional amendment, how it has been fleshed out and defined over time through case law, and the bases of some more recent critics of this amendments and current interpretations.

88-184 Topics in Law: The Bill of Rights
Spring: 9 units
This course examines the history and place of the Bill of Rights in our nation’s constitutional framework. It focuses on the historical origins of the U.S. Constitution, of each of the first ten amendments to the Constitution (that we refer to as the “Bill of Rights”), how the meanings and interpretations of these have evolved over time, and what they mean to us today. Each article of the Bill of Rights will be examined in terms of its original intentions, and then through cases that have challenged and been interpreted through the Bill’s articles.
88-198 Research Training: Social and Decision Sciences  
Fall and Spring  
This course is part of a set of 100-level courses offered by H&SS departments as independent studies for second-semester freshmen, and first- or second-semester sophomores. Most courses are designed to give students some research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as elective units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/ restrictions: for H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative GPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

88-205 Comparative Politics  
Spring: 9 units  
The aim of the course is to discuss, analyze and compare democratic, totalitarian and authoritarian regimes. Each of the models will be analyzed both from a theoretical and a practical perspective. Emphasis will be placed on understanding the rights and obligations of the individual, the form in which the government functions and the process through which countries arrive at a particular form of government. The course will focus on British democracy, Nazi Germany, and Chile’s authoritarianism. The course will conclude with an analysis of current processes of democratization and transition to capitalism. No prerequisites.

88-220 Policy Analysis I  
Fall: 9 units  
This course provides an introduction to theories and methods for policy analysis. The main focus of the course is to develop an understanding of how theories from social science, such as economics, can help us understand policy issues such as allocation, regulation, and welfare. Throughout the course we analyze outcomes produced by private markets, by examining consumer choice, the supply and demand of factors and produced goods, and general and partial equilibrium. We also analyze the efficiency and welfare properties of such outcomes, paying special attention to the role of policy in influencing market outcomes. We consider how policy can address the efficiency and welfare shortcomings of markets that may result from informational asymmetries, industrial organization, moral hazard, transactions costs, and bounded rationality. Markets are compared to this light with organizational, governmental, and other modes of resource allocation. Grading will be based mainly on 3 exams. Homework assignments and/or quizzes will comprise a smaller part of the grade. Priority access is given to SDS junior and senior students.

88-221 Policy Analysis II  
Spring: 9 units  
This course is an extension of Policy Analysis I and focuses on a normative analysis of government action. The course begins by considering justifications for government action drawing on work in political philosophy. It then compares different institutional approaches governments may adopt in attempting to correct market failures and in pursuing objectives other than efficiency. The basic concepts and tools of cost benefit analysis are then presented. Students are involved in individual and group projects applying the class material to specific policy issues. Prerequisites: 88-220.

88-223 Decision Analysis and Decision Support Systems  
Spring: 9 units  
This course emphasizes explicit procedures for analyzing complex decisions. The topics covered include: decision trees and other models of decisions involving uncertainty; methods for quantifying preferences and expert opinion; risk analysis; and the development and use of computerized decision aids ranging from spreadsheet programs to highly specialized decision support models. Prerequisites: 36-201 or 36-211 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207 or 36-207.

88-251 Empirical Research Methods  
Spring: 9 units  
This course teaches students how to evaluate and conduct original research regarding human behavior, whether it be in economic, social, or political settings. The course gives students practical experience in many of the most commonly used research techniques, including surveys, experiments, and quasi-experimental analysis. Although the course focuses primarily on the relationship between formulating research questions and implementing the appropriate methods to answer them, students can expect regularly to apply the statistical techniques learned in the course prerequisites, including regression. Prerequisites: 36-201 or 36-207 or 36-247.

88-252 Empirical Research for Social Science and Policy  
9 units  
This course explores what we can learn from applying regression analysis to questions in the social sciences and policy analysis. A central theme is that regression gives us ways to test whether phenomena are associated, but drawing conclusions about causality requires critical thinking about the types of processes that can generate any observed associations. Students will learn how to articulate causal hypotheses, prepare data, construct specific measures of the phenomena described in a proposed causal model, and interpret regression results. We will also examine how regression techniques can often be extended to evaluate which potential causal processes are consistent with further patterns of association in the data. The course emphasizes active learning and makes extensive use of interactive exercises. Half of our class time will be spent in a computer lab and the last several weeks will be devoted to small-group projects and an applied policy analysis topic. Examples of research questions in the exercises include: • Does lead exposure reduce IQ? • Does democracy reduce the chance of going to war? • Does too much economic competition undermine innovation? • Does watching TV cause obesity? • Do curfew laws reduce crime? • Does burning of fossil fuels raise global temperatures? • Does wealth increase the rate of formation of new businesses? Prerequisites: 36-201 or 36-207 or 70-207.

88-260 Organizations  
Fall: 9 units  
Even in a “market” economy, the preponderance of economic activity is carried out through firms and other organizations. The course begins by examining economic theories of the firm, and explores some of the canonical questions, such as why are their firms, how the separation of ownership and control of a firm shapes decision making, what determines the boundary between organizations and markets (e.g., make-or-buy decisions), what types of firms are most innovative, and how new technologies affect organizational structure. A second set of issues concerns how various organizational forms motivate, or fail to motivate, employees. The central concepts will be fleshed out by examining business firms, as well as not-for-profit enterprises, political parties, and government agencies.

88-283 Decision Making in Clinical Psychology  
Spring: 9 units  
This course surveys decision making surrounding core issues in clinical psychology. It includes an overview of how decisions are made in the prediction of mental illness, risk for violence, and the probability of recovery among individuals with mental illness. It also involves students in constructing and evaluating treatment methods and discrepancies between professional judgments and actual outcomes. The final section of the course will shift the focus to decision making by individuals with specific disorders. Here we will examine decision making among individuals with addictions, eating disorders, aggressive behavior problems, and neurological illnesses.

88-302 Behavioral Decision Making  
Fall: 9 units  
Behavioral decision making is the study of how people make decisions, in terms that can eventually help them to make better decisions. It draws together research from psychology, economics, political science, and management, among other fields. It has applications that range from managing potentially hazardous technologies, to involving patients more fully in the choice of medical procedures, to the design of computer-intensive systems. The course covers behavioral theories of probabilistic inference, intuitive prediction, preference, and decision making. Topics include heuristics and biases in inference and prediction, risk perceptions and attributes, strategies for combining information from different sources and dealing with conflicting objectives, and the roles of group and emotional processes in decision making. The course emphasizes the mutually reinforcing relationship between theory and application. Prerequisites: 36-201 or 36-207 or 36-211 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.
88-314 Politics through Film
Summer: 9 units
In this course we will use films, readings and discussions to enhance our ability to analyze, understand, and explain politics. The course is about political power, authority, leadership, ideologies, war, nationalism and resistance to authority. We will use major commercial films to explore some fundamental political problems regarding governments and societies. The central themes to be discussed in both the readings and the films will be tyranny and its impact on the people, resistance to tyranny and authority, and nationalism and war. The question of tyranny will be analyzed in the context of a variety of historical experiences, including Nazi Germany, Stalin’s regime, Latin American experiences, and racial problems in the U.S. To analyze the problem of nationalism and war, we will use material dealing with World Wars I and II and Vietnam.

88-316 Game Theory
Intermittent: 9 units
Game theory is the branch of decision theory in which decision problems interact. Due to its flexibility and strategic nature, game theory is used heavily in other academic areas such as economics, political science, biology, and even competitive sports. This course will cover those parts of game theory of special interest to social scientists. We will discuss specific elements of the formal theory of games as well as experimental results. Throughout the course we will examine applications of game theory to problems across the social sciences.

88-326 Theories of International Relations
Fall: 9 units
This course has three major dimensions. Assumptions and propositions of the leading theories of international relations will be reviewed. This course also seeks to ensure that students clearly understand how newer theoretical approaches to the study of international relations build upon or depart from classical theories. Finally, theories will be tested against the historical record by examining major policy decisions and events such as the Cuban missile crisis, the Vietnam War, the Soviet invasion of Afghanistan, the Persian Gulf War, and the current war against global terror.

88-336 Autocrats and Democrats
Intermittent: 9 units
The international system is populated by countries with many different types of national governments. A common simplification of the many diverse political systems in the world is to divide them between democratic states and non-democratic states. Non-democratic states are also often further simplified as just “autocracies.” This simplification misses many key institutional differences between democracies and autocracies. Furthermore, and even more dangerously, it causes us to overlook key similarities between these two regime types. In this course we have three aims. First, we unpack what is meant by autocracies: What are the different types of non-democratic regimes out there? Second, we evaluate the strategic incentives faced by all types of autocratic leaders and democratic leaders. Finally, we ask what these differences mean for international relations, for democracy-building, and for the future of the organization of national governments. If some of the roots of conflict come from misunderstandings between autocracies and democracies, perhaps a better understanding will contribute to heightened international cooperation, not conflict. An additional goal throughout the course is to build student familiarity with the different types of autocracies out there: We often think of them as dangerous, as unfriendly, or as deeply foreign, simply because we do not understand them or know much about them. Through this exploration, students will be asked to re-consider much of what they’ve thought about both democracies and non-democracies. Class assignments will ask students to critically examine existing theories of political organization and apply their knowledge to real world cases, both historical and contemporary.

88-341 Organizational Communication
Fall: 9 units
Much of the work in groups and organizations consists of communication. You communicate to get information that will be the basis of decisions, to provide a vision for the people who work for and with you, to coordinate activity, and to sell yourself and your work. The goal of this course is to identify sources of communication problems within an organization and ways to overcome them. To do this requires that we know how communication normally works, what parts are difficult, and how to fix it when it goes wrong. The focus of this course is on providing you with a broad understanding of the way communication operates within dyads, work groups, and organizations. This course is not a practicum in public speaking or writing, although you will get some experience writing, speaking, and managing impressions. Rather the intent is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from both the research and the managerial literatures. Among the topics considered are managerial communication, persuasion and conformity, self presentation and person perception, social networks. Cases and group projects give you an opportunity to apply what you’ve learned.
Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.

88-343 Economics of Technological Change
Intermittent: 9 units
This course will consider the determination of innovative activity and performance, and the effect of innovation on productivity, economic growth, and social welfare. We will focus particularly on the characteristics of markets and firms that influence industrial innovation. Such characteristics include, for example, market concentration, firm size, the strength of patent protection, and the vitality of the basic science and technology underlying innovation in a given industry. We will also study the economics of the adoption and diffusion of innovation. In addition to drawing on economic theory, the course will emphasize empirical studies of innovation and technological change, and will selectively exploit case study and institutional studies.
Prerequisites: 73-250 or 73-251 or 88-220.

88-345 Perspectives on Industrial Research and Development
Intermittent: 9 units
This advanced reading seminar will consider the determination of innovative activity and performance, and the effect of innovation on productivity, economic growth, and social welfare. We will focus particularly on the characteristics of markets and firms that influence industrial innovation. Such characteristics include, for example, market concentration, firm size, the strength of patent protection, and the vitality of the basic science and technology underlying innovation in a given industry. We will also study the economics of the adoption and diffusion of innovation. In addition to drawing on economic theory, the course will emphasize empirical studies of innovation and technological change, and will selectively exploit case study and institutional studies.
Prerequisites: 73-250 or 73-251 or 88-220.
88-347 Complex Technological Systems: Past, Present, and Future
Intermittent: 9 units
The Internet is only the latest example of a complex technological system that fundamentally alters the way that we act in and think about our world—and about technology itself. During the last two centuries such complex technological systems have emerged, ranging from transportation systems such as the railroad and mass-produced automobiles running on paved roads and superhighways to networked information systems including the telegraph, the telephone, and radio and television. What are the common features of these complex technological systems? When do they emerge? How are national and international standards for these systems established? How far reaching are the consequences of these systems in society, business, and in other complex technological systems? Can they be predicted? Can they be controlled? Can such complex technological systems be fully comprehended and modeled? In a world in which many of these systems are interconnected, how vulnerable are current societies (such as those in the West) that depend on them, especially in an age of global terrorism? These are but some of the questions this lecture and discussion course will tackle using cases from the past, the present, and the future. Students are graded through weekly quizzes, midterm and final examinations, and class participation. Prerequisites: junior or senior standing.

88-349 War and Peace
Intermittent: 9 units
This course explores the conditions that lead to the initiation, escalation, spread, and termination of international conflict as well as the circumstances that promote, preserve, or restore peace. We will explore topics such as balance of power, uncertainty, commitment problems, alliances, arms races, appeasement, and the democratic peace. In addition, we will discuss theories and cases of international mediation and peacekeeping, and evaluate their effectiveness. We will also address the role of the US in promoting international peace. The course emphasizes the application of simple game theoretic models of rational action as tools for assessing relations between nations, coupled with statistical and historical analysis of classes of events. No mathematics beyond high school math is needed for this course.

88-352 Environmental Economics and Policy
Fall: 9 units
The course will introduce students to the economic analysis of problems associated with private and collective use of environmental resources and to the analysis of public policy options to environmental problems. Policy relevant examples will be used throughout the course. When thinking about protecting nature environmental economics has traditionally focused on the idea that market failure (externalities, non rival goods, asymmetric information) is the critical source of economic inefficiency. Based on this idea economists have designed policies for environmental protection, which include Pigouvian taxes, marketable permits, liability rules and mechanisms design. We will start from the theories of externalities, market failure and mechanism design, and we shall explore the causes of these problems and some of the potential remedies using the competing/complementary lenses of traditional and behavioral economics. To organise and evaluate alternative environmental policy options environmental economics has traditionally used rational choice theory. According to rational choice theory, people respond to policy instruments in their own self-interests and take all possible consequences into account. Behavioral economics has emerged to challenge this traditional view by documenting how people make choices and state values that deviate from the conventional rationality model. We will try to understand the behavioral economics underpinnings of environmental policy and how understanding the success and failure of conventional economic theory can help make good environmental policy better. Prerequisites: 73-150 or 88-220.

88-357 Comparative Foreign Policy: China, Russia, and the US
Intermittent: 9 units
The purpose of this course is to compare and analyze the Foreign Policies of China, the United States and the former Soviet Union. The first section of the course will be geared to analyzing the foreign policies of the three major powers since World War II until today. The second section will be devoted to analyzing major foreign policy problems and the position that China, the US, and the former Soviet Union had, or have, in relation to those problems. Among the issues discussed will be the Arms Race, Nuclear Proliferation, the conflicts in the Middle East, the end of communism, and the war in Afghanistan.

88-359 Globalization
Spring: 9 units
Globalization entails an erosion of the national borders and the expansion of trade and technology. In this course we will analyze the political and economic implications of the process of globalization and its impact on Developed and Less Developed Countries. Among the issues discussed will be the increased power of Transnational Corporations and Nongovernmental organizations as well as the power of International Organizations such as the World Bank and the IMF. The course will also focus on the impact of globalization on poverty and wealth across the world.

88-360 Behavioral Economics
Intermittent: 9 units
This course introduces students to behavioral economics, an emerging subfield of economics that incorporates insights from psychology and other social sciences into economics. We will examine evidence on how human behavior systematically departs from the standard assumptions of economics, and then investigate attempts by behavioral economists to improve economic analyses. Prerequisites: (21-112 or 21-120) and (73-100 or 73-150 or 88-220).

88-362 Diplomacy and Statecraft
Intermittent: 9 units
This course introduces students to the fundamental principles of the art of statecraft; major concepts and theories of diplomacy; and the main tools of diplomatic practice and key venues in Africa, Asia, the Americas and Europe. Students will examine the relationship between diplomatic and military power; the use of, or resort to, coercive measures; the role of public diplomacy; and the challenges of multilateral negotiations. Contemporary global issues such as the responsibility to protect, conflict resolution and UN peacekeeping will be explored through focused case studies of Liberia, Darfur and the Democratic Republic of the Congo.

88-363 Behavioral Economics Theory
Intermittent: 9 units
This course introduces students to the fundamental principles of the art of statecraft; major concepts and theories of diplomacy; and the main tools of diplomatic practice and key venues in Africa, Asia, the Americas and Europe. Students will examine the relationship between diplomatic and military power; the use of, or resort to, coercive measures; the role of public diplomacy; and the challenges of multilateral negotiations. Contemporary global issues such as the responsibility to protect, conflict resolution and UN peacekeeping will be explored through focused case studies of Liberia, Darfur and the Democratic Republic of the Congo.

88-365 Behavioral Economics and Public Policy
Intermittent: 9 units
Economics has up to now been the social science that has been most broadly and deeply involved in public policy. With its rational choice perspective, the economic perspective has tended to favor certain types of policies – namely those that enhance the efficiency of market mechanisms and lower the cost of information. In this course we will spend the first several classes reviewing the assumptions, implications for public policy and limitations of the rational choice perspective. The remainder of the course will then be devoted to examining different public policy issues, including saving, health care, crime and drug abuse, through the competing lenses of traditional and behavioral economics. Prerequisites: 73-100 or 73-150 or 88-220.

88-368 Conflict, Human Rights and Development
Intermittent: 9 units
In the words of Paul Collier, “Seventy-three percent of people in the societies of the bottom billion have recently been in a civil war or are still in one”. The words of Collier summarize very effectively the purpose of this course because what we will try to do in the next twelve weeks is to study the impact that human rights abuses and conflict have on development. The course is geared to highlight the limitations of human rights policies, the destructive societal and economic effects of conflicts, and the policies and actions geared to reverse those detrimental effects. 1 Paul Collier, The Bottom Billion: Why the Poorest Countries Are Failing and What Can be Done About It, Oxford University Press, 2007, p.17 Prerequisites: 73-100 or 73-150 or 88-220.
88-370 African Politics
Intermittent: 9 units
The course will introduce students to the political history of pre-colonial administration, conflict resolution and relations between political entities in Africa. The impact of slavery and colonialism on the continent will be discussed. Relations between colonial state and the indigenous political forces will be discussed with special emphasis on selected African territories. Nationalism and resistance to foreign rule and post-colonial state will be discussed. Topics such as economic development and foreign aid will be covered with special emphasis on structural adjustment programs. Specific case studies on civil wars, conflict resolution, and civil societies will be discussed. Issues of Pan-Africanism, African unity, and impact of globalization on African politics will also be covered.

88-371 Entrepreneurship, Regulation and Technological Change
Intermittent: 9 units
There is a growing interest in understanding the interrelationships between regulatory institutions and innovations. Certainly, opportunities for innovative activities take place in the context of the extant public policy institutions (e.g., entry restrictions in telecommunications, environmental performance standards, intellectual property protections). Consequently, entrepreneurial activity plays a key role in identifying and exploiting these opportunities. In this course, we examine the role that entrepreneurs play in the interrelationships between regulation and technological change. The objectives are to develop and articulate an understanding of the theory, nature, and role of entrepreneurship in the American economy; the theory, nature, and role of regulation in the American economy; and the theory, nature, and role of the dynamic interaction of entrepreneurship and regulation in the American economy. Students will evaluate historical cases in which new or changing regulation presents opportunity for entrepreneurial entry in business, as well as historical cases in which entrepreneur activity (in the form of innovation) presents new needs or opportunities for regulation, thereby presenting—or constraining—further opportunities for entry. The course is broken into a series of blocks, and each week there will be a set of readings posted on Blackboard. Blackboard will be used to facilitate communication, including announcements, readings, lectures, and assignments. Prerequisites: 73-150 or 79-300 or 88-202 or 88-220.

88-377 Attitudes and Persuasion
Spring: 9 units
This advanced undergraduate course will focus on the topic of attitude change and how various persuasive techniques are used to shape human behavior. The dynamics of propaganda and what makes the techniques effective on social and consumer decisions will be addressed. The primary goals of the course are to 1) understand the dynamics of attitude change; 2) explore the mechanism by which attitude change techniques operate and 3) examine relevant theories and research in persuasion. Examples of topics covered include the origins of attitudes, how attitudes influence judgments, social power and attitude change, and how individual decisions are influenced by the mass media. Classic and contemporary research in the area of persuasion will be examined in the form of course readings and assignments. Prerequisite: 85-241.

88-378 International Economics
Intermittent: 9 units
This course analyses the causes and effects of commercial and financial transactions between nations and the major policy issues raised by these transactions. The first half focuses on international trade and commercial policy using the tools of microeconomic analysis. The second half deals with balance of payments and exchange rate issues with emphasis on problems of macroeconomic policy in open economies.

88-380 Grand Strategy in the United States
All Semesters: 9 units
88-384 Conflict and Conflict Resolution in International Relations
Intermittent: 9 units
Course will introduce students to concepts of conflict, conflict resolution, and peace in international relations. Causes of war, alliances, and role of outside actors in conflict will be examined. There will be also discussion on foreign policy decision making, mediation, negotiation and international law. The following specific cases will be discussed – the Middle East Peace Process (Security Council Resolution 242, Camp David, Oslo Agreement and Geneva Accord); Indo-Pakistan dispute (Lahore Declaration 1999); War in Bosnia and Herzegovina and the Dayton Peace Accords; El Salvador Peace Agreement (between the Government of El Salvador and the Frente Farabundo Marti para la Liberacion Nacional); and the Aligers Agreement between Eritrea and Ethiopia. Globalization, terrorism, and conflict resolution will also be covered.

88-385 Managerial Decision Making
Fall: 9 units
People in organizations make decisions, with important consequences, every day. Therefore, an understanding of decision-making is important in any education in management or economics. However, while a large number of courses in these curricula expose students to how decisions should be made, very few focus on how people actually make choices. This course addresses this topic by focusing on how decisions made by real people are in particular decisions in business contexts - differ from the theoretical predictions of rational decision-making. We specifically focus on common areas of biased decision-making, their basis, and how they might be corrected. The focus of the course is on both individual and competitive decision-making.

88-386 Desires and Decisions
Spring: 9 units
This course explores how the desirability of experiences and (consumer and public) goods are determined. Through the lens of psychological research we will explore (1) the construction of preferences, (2) how preferences are affected by factors such as context, adaptation, memory, culture, and emotion, and (3) attempt to understand how the malleability of our preferences affects our personal decisions, economic markets, the law, and public policy. Class meetings will include a mixture of lecture and discussion, with a stronger emphasis on discussion. Throughout the course, the emphasis will be on learning to critically evaluate advanced theories and research findings of decision science and psychology, and carefully articulate those critiques orally and in writing. Prerequisite: 88-120.

88-387 Social Norms and Economics
Intermittent: 9 units
Social norms play an important role in individual economic decisions and influence economic exchange outcomes. This raises several important questions. What mechanisms are effective in enforcing social norms? To what extent and in what contexts might we expect norm obedience absent external economic incentives? How should we take into account the role of social norms when designing economic institutions? This course discusses experimental research in economics, law and psychology that takes steps towards answering these and other related questions.

88-388 Psychological Models of Decision Making
Intermittent: 9 units
This course provides an introduction to several techniques and theories for modeling psychological processes and decision making. The topics covered include: signal detection theory, individual decision modeling, and multidimensional scaling. The course will include an introduction to the theory behind the models as well as “hands on” computational applications of the models to data. The topics covered in this course can be used in a variety of applied settings—ranging from medical and public policy to marketing and psychological research—to produce simplified representations of seemingly complex phenomena. Prerequisites: (36-201) and (21-112 or 21-120).

88-389 Terrorism and Insurgency
Intermittent: 9 units
This course offers an introduction to the study of terrorism and insurgency, and government policies to counter these types of domestic political violence. We will read and discuss recent leading academic and policy research that addresses questions such as what are the causes of terrorism and insurgency? Who becomes a terrorist or an insurgent? Do terrorists and insurgents achieve their goals? What works and what does not work in counterterrorism and counterinsurgency? The goal of this course is to demonstrate how theoretical and empirical approaches in social sciences can be used to answer questions about terrorism and insurgency. In addition, the course is designed to help students critically evaluate the arguments in the literature, and to be able to engage debates about these issues in informed way.

88-391 Technology and Economic Growth
Fall: 9 units
The importance of economic growth is difficult to overstate. The more than tenfold increase in incomes in the United States over the last century is the result of economic growth. So is the fact that incomes in the United States and Western Europe are at least thirty times greater than incomes in much of Sub-Saharan Africa. Economic research has clearly identified technological innovation as the engine of long-run economic growth. This course seeks to provide students with analytical frameworks that will enable them to understand the economic growth process, the role that technological innovation plays in that process, and the policies and institutions that can enhance and sustain technological innovation in industrialized societies.
88-398 Independent Study

All Semesters

Students conduct independent academic study under the supervision of a Social & Decision Sciences faculty member. Students who wish to engage in an independent study should seek out a faculty member whose interests are appropriate to the topic. Prerequisite: Permission of a faculty sponsor.

88-399 Undergraduate Research

Students conduct research under the supervision of a Social & Decision Sciences faculty member. Students who wish to engage in research should seek out a faculty member whose interests are appropriate to the research. Prerequisite: Permission of a faculty sponsor.

88-402 Modeling Complex Social Systems

9 units

Many of the biggest challenges facing modern societies—maintaining global political and financial stability, protecting against terrorist acts, cooperating to solve collective problems such as climate change or corruption—are complex. They are not simply complicated; they arise as interacting agents create various feedbacks that result in, often unintentional, emergent phenomena. Confronting these challenges requires an understanding of the properties of complex systems. In this course, we will provide an overview of complex systems theory and concepts. You will learn the fundamental properties of complex adaptive systems and how to apply these insights to a variety of key social science problems. We will introduce and analyze computational and mathematical models, as well as qualitative models, so you should have some familiarity with basic probability and algebra. We will explore topics such as inequality, networks, information spread, community formation, the evolution of cooperation, and the stabilization of financial markets. We will cross traditional disciplinary boundaries and venture into economics, political science, sociology, finance, cognitive science, computer science, physics, statistics, and mathematics as needed. Students will be expected to think critically about how to apply modeling insights to the real world, taking account of the social, political, and economic implications of proposed policies. They will express their ideas in class discussions, presentations, and written reports. The course will culminate with students engaging in a research project to model a complex social system of their choice. Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.

88-403 Network and Social Systems

Intermittent: 9 units

Networks are structured and highly connected systems. The necessity to cope with major phenomena like disease spread, terrorism, organized crime and financial crisis, requires understanding of the fundamental properties of complex (social) networks. In this course, we will first provide an overview of the theory of networks. We will then focus our attention on networks in social sciences and, in particular, on the nature of social links, as the perception of the nature of a social connection may be subjective to some extent. We will learn the basic structural and dynamical properties of networks, and how to apply these concepts to real social systems. We will investigate, starting from real data, the structure of several social networks including phone call and email networks, friendship networks, financial networks, trading networks, and crime networks. We will also explore the dynamics of processes occurring on networks, such as disease spread and market contagion, and macroscopic phenomena related to these processes, including information cascades and herding. Students will be expected to think critically about concepts, models and empirical evidences presented in class. They will also be expected to apply concepts and data analysis tools to real world networks.

88-405 Risk Perception and Communication

9 units

Throughout their lives, people make decisions about risks that may potentially affect their health, safety, finances, use of technology, and effects on the environment. This course will review the risk perception and communication literature, focusing on theoretical and methodological issues as well as practical implications for educators, public health officials, engineers, economists, and other experts who aim to teach people about risks. We will discuss how to design surveys to increase our understanding of the problems people face when making decisions about specific risks, and how to design communication materials that help people to improve their decisions. We will highlight examples and applications taken from multiple disciplines, including health psychology, adolescent decision making, environmental science, and engineering. Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247 or 70-207.

88-407 Health Risk Communication

9 units

This course will cover the relationship between risk perception and health behavior, focusing on how to effect behavior change through communication. The course will begin by exploring how people make decisions about their health, with an emphasis on how we as researchers can learn what factors affect such decisions. We will then turn to the question of how to change unhealthy behaviors by helping to improve this decision making. Finally, the course will cover strategies for evaluating these techniques, to determine whether they have been effective. Throughout the semester, students will conduct a multi-stage research project, beginning by assessing people’s decisions on a health topic of their choice and ending with the creation and production of a health communication intervention and a plan for its evaluation. Readings will consist primarily of original journal articles describing research and reviews, which students will be expected to read prior to class for discussion. Grading will be based on mid-term and final papers describing the research project and on short assignments throughout the semester relating to class readings. This course is aimed at students with a background in Decision Science, Psychology, or related fields. A course on research methods or experimental design is recommended. However, the topic may also be of interest to those studying health or design, and students in these fields are welcome.

88-408 Attitudes the Media and Conflict in International Relations

9 units

This course examines the sources of political attitudes, the effect of the media on attitudes, & how both interact to influence international conflict, with some attention also to civil war, terrorism, & other forms of violence. The first half of the course considers attitude formation & the media, & the second half focuses on conflict. Specifically, we begin by considering different social science perspectives on attitude formation, drawing from research in behavioral economics, public opinion, decision science, & political psychology. We then consider the effect of the media on attitudes, & the incentives facing leaders of democracies and non-democracies to manipulate the media. Here, we draw primarily from research in comparative politics & IR, but we also cover information science & systems thinking about the spread of ideas. Finally, we consider the effect of attitudes on conflict by examining theories of IR & conflict at multiple levels of analysis: from intra-group conflict, to the relationship between domestic politics & IR, to the “first image” in IR, and to theories of cooperation under anarchy. Throughout, the diverse collection of social science theories will be both illustrated by & critically evaluated through the consideration of contemporary and historical issues, including the rise of China, energy security, human security, & inter-ethnic conflict. Students will leave the class with a deeper understanding of the relationship between ideas & conflict, how the media affects political outcomes, & the diversity of causes & consequences of international conflict. Students will be expected to think critically about the theories and arguments presented – they should not simply accept them at face value; rather, students should come prepared to discuss and question the assumptions, relevance, and explanatory power of various ideas presented.


Spring: 9 units

In the early years of the 21st Century, nations are more economically integrated than at any other point in human history. This presents business leaders and consumers with unprecedented opportunities and challenges. This course seeks to equip future business leaders to exploit these opportunities and cope with these challenges. The course will accomplish that goal by providing students with a systematic understanding of the fundamental aspects of the global business environment that influence business decisions and behavior. Managers must understand the structural economic factors that determine locational advantages, the way government policies both promote and restrain the integration of national economies with the global economy, and the impact of volatility in the global macroeconomic environment on international business strategy. These issues will be studied using the analytical tools and concepts of international economics, and case studies will be used to relate these concepts to actual business problems. We will also invite international business managers to share their practical experience and insight at several points over the course of the semester. Prerequisites: 73-100 or 88-220.
88-411 The Rise of the Asian Economies
Spring: 9 units
For most of the past quarter century, no region of the world has been more economically dynamic than Asia. This course is designed to provide students with the essential knowledge necessary to evaluate opportunities and risks in Asia. The course will use analytical tools drawn from economics and finance, business cases, and guest lectures to focus on the key strengths that sustained economic growth in East Asia for decades, the weaknesses that undermined that growth in the late 1990s, and what lies ahead. The course will also examine Indian economic growth since the early 1980s, and compare India’s experience with that of the East Asian economies. A special focus will be placed on recent developments in India and China and the prospects for continued growth in those countries over the next decade.
Prerequisites: 73-100 or 73-150 or 88-220.

88-412 Economics of Global Warming
Spring: 9 units
The scientific community has concluded that human industrial activities are causing global temperatures to increase. Coping with the environmental, economic, and political consequences of this change is considered by many to be the preeminent public policy challenge of the 21st century. In this course, we will investigate the basic science of climate change, the prospective economic impact of global warming, the uncertainty involved in long-run climate forecasting, and the technological alternatives available to us as we seek to mitigate the impact of human industrial activity on global warming. The heart of this course will be an in-depth analysis of the policy options available to the United States and the global community. We will investigate the economic costs of these options and the way political realities are likely to shape and constrain policy at the national and international levels.
Prerequisites: 73-100 or 73-150 or 88-220.

88-413 Energy and Climate: History, Science, Technology, & Policy in the US 1776-2076
9 units
This course provides CMU students with a historically grounded, technically informed, and policy-centered examination of energy and climate in the United States from the American Revolution to the nation’s tri-centennial, by which time the nation will either have taken the necessary action to avoid massive catastrophes related to global warming or will be destined for—perhaps already experiencing—a series of vastly catastrophic climate events that visit apocalyptic-like suffering and misery on large segments of the nation. Energy procurement and expenditure in the US and climate change have been surprisingly linked over the nation’s entire. Now is the time for CMU students to understand these relationships historically, technically and scientifically, and politically and geopolitically. The course is structured around the reading and discussion of landmark scholarship on energy and climate seen together by lectures, films, and various unorthodox pedagogical methods.

88-415 Global Competitiveness: Firms, Nations, and Technological Change
9 units
This course introduces students to the fundamental principles surrounding global competitiveness and technological change in the 21st century. The past twenty years have seen dramatic changes in innovation ecosystems in the U.S. and internationally. Alone within the U.S., there has been a sharp decline in corporate R&D labs, matched by the global fragmentation of firm activities. At the same time growing linkages have been observed across institutional – firms, government labs, and universities – and national borders. These changes raise critical questions about the new rules of the game driving technological change in the 21st century. This course sheds insights into these questions through the lenses of competing economic, sociological, and political science theories on the structures supporting technological change. The course is broken into three sections. The first section introduces students to theories of the firm, bureaucracy, institutional economics, and social networks as competing frameworks within which to understand technological change. The second section presents the contemporary literature on the technological change, including creative destruction, dominate designs, industry life cycles, and networks of innovators. The concluding section leverages lessons from the preceding sections to evaluate national innovation systems, and the factors that lead to national comparative advantage. Students should leave the class able to reflect competently on what the existing literature tells us about the factors influencing global technology competitiveness, and on how modern changes in the structures supporting innovation as well as technology itself may be changing the rules of the game for firms and for nations. The course is open to seniors; also to juniors with instructor permission.

88-419 Negotiation
9 units
Negotiation is a process in which two or more parties undertake a process to resolve conflicting interests. Decision makers use negotiation in a variety of circumstances – to reach agreements among countries, among employers and employees, among firms, and among family and friends. There are two different sections of this course (students are not permitted to take both): Domestic section: The objective of this course is to understand the effectiveness of negotiations and how the structure of the negotiation environment affects the outcomes achieved. Students will learn to analyze the features of the negotiation environment, develop an understanding of effective negotiation strategies, and identify the barriers to reaching wise agreements. This course will focus on a variety of context: public policy negotiations, business negotiations, and interpersonal negotiations. International section: The objective of this course is to understand the process of negotiations and how the structure of the negotiation environment affects the outcomes achieved. Students will learn to analyze the features of the negotiation environment, develop an understanding of effective negotiation strategies, and identify the barriers to reaching wise agreements. This course will focus on negotiations in primarily international contexts.

88-421 Emotion: Physiology, Neurobiology, Expression, and Decision Making
Intermittent: 9 units
This course examines advanced topics in emotion from a psychological perspective. Emotions are thought to relate to numerous response channels including physiology, movement and expression (facial and vocal), and each of these components and their relationships will be examined. Class will center around discussion of primary sources.
Prerequisites: 85-211 or 88-120.

88-423 Institutions, Entrepreneurship, and Innovation
Spring: 9 units
Institutional environment and public policy greatly affect incentives determining the direction of entrepreneurial activity and innovation that are the engines of economic growth. In societies with poor institutions, entrepreneurial talent is mostly directed towards seeking rents rather than generating productive innovations. But even in modern capitalist economies entrepreneurial activity and innovation are strongly influenced by public policies, for example, those related to intellectual property rights. This course seeks to provide students with analytical frameworks that will enable them to understand how various formal and informal institutional arrangements and public policy decisions influence entrepreneurial activity and innovation and how this, in its turn, affects economic efficiency and growth potential of nations.

88-424 Decision Theory and Rational Choice
Intermittent: 9 units
Introduction to the concept of rational choice and its relevance (benefits and limitations) as a tool to analyze different decision problems. Judgment and analysis of decisions by presenting a contrast between the rational choice model from economics and many documented biases and mistakes that can depart from the aforementioned rational model. Topics include rational preferences and optimal choice, judgment and choice biases, mistakes in analyzing statistical data, and basic theories of decision-making under risk and uncertainty.
Prerequisites: 21-112 or 21-120.

88-435 Analytical Methods for Complex Social Systems
Intermittent: 9 units
Research in the social sciences has extensively investigated how decision makers behave when they encounter many different and difficult decision scenarios. This course serves as an introduction to how relevant research from decision and social sciences can be applied to complex environments such as those encountered by governments (intelligence and policy analysts) and private industry (business strategists and information officers). Topics of operations research, game theory, signal detection theory, and decision theory (heuristics and biases) will be discussed with respect to the application of these theories to improve the performance of individuals and groups within a complex social system.

88-444 Public Policy and Regulation
Intermittent: 9 units
Regulations are a significant policy tool of government. How society and the economy, will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/ or benefits never being realized. This course will review the basics of regulatory policy and using historical examples, will explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives.
88-451 Policy Analysis Senior Project
Spring: 12 units
Students in this course apply the research and analytical methods learned in their other courses to a real-world problem. Students decide how to structure the problem, divide into teams responsible for its different parts, identify and analyze relevant literature, collect data, synthesize their results, and present their conclusions in oral and written form to a review panel of individuals concerned with the problem. Faculty members help them along the way. Performance is based on students' contribution to the process and substance of the class, as observed by the faculty and by their fellow students. One or two such projects is offered every term. A complete list of previous topics is available from the department. Course is open only to seniors in SDS.

88-452 Policy Analysis Senior Project
Fall: 12 units
Students in this course apply the research and analytical methods learned in their other courses to a real-world problem. Students decide how to structure the problem, divide into teams responsible for its different parts, identify and analyze relevant literature, collect data, synthesize their results, and present their conclusions in oral and written form to a review panel of individuals concerned with the problem. Faculty members help them along the way. Performance is based on students' contribution to the process and substance of the class, as observed by the faculty and by their fellow students. One or two such projects is offered every term. A complete list of previous topics is available from the department. Course is open only to seniors in SDS.

88-499 Advanced Undergraduate Research
Students conduct research at an advanced level under the supervision of a Social & Decision Sciences faculty member. Students who wish to engage in advanced research should seek out a faculty member whose interests are appropriate to the research. Prerequisite: Permission of a faculty sponsor.

88-505 Undergraduate Internship
All Semesters
An internship is an approved and monitored work experience that can be related to an academic field of study through active reflection and specific learning goals. Students must work at least 10 hours per week for the semester at the internship. Additionally, students will also keep in regular contact with a faculty member in Social and Decision Sciences, who will assign and evaluate academic work. Internships are available for 3, 6, or 9 units, depending on the type and amount of academic work produced. Students are responsible for finding their own internships and faculty sponsors, although assistance is available from the department.

Software Engineering Courses

17-400 Electronic Voting
Fall: 12 units
After the punched-card disaster in Florida in 2000, the U.S. has been rushing to replace old voting equipment with direct-recording electronic (DRE) machines (sometimes incorrectly lumped together as "touchscreens"). Recent examination of these machines by computer security experts has revealed significant security vulnerabilities, leading to a call by some computer scientists to either discontinue use of such machines or equip them with a printing device that would enable the voter to see a paper record of how she had voted before leaving the voting booth. This "voter-verifiable paper trail" idea has polarized the voting community, leading to bills in Congress and in some states to require it but with vendors, election officials and public advocacy groups strongly in opposition. Each meeting will be devoted to a technical lecture followed by an hour of general discussion. The course is open to juniors, seniors and graduate students. Students from outside SCS may also participate. No advanced technical background is required except for some security and cryptography topics. Each student will participate in a team project, with a presentation to be made on the last day of the course. Grading will be based on class participation, the project paper and a final exam. There will be assigned readings but no midterm or written homework. This course counts as an elective in the Computation, Organizations and Society (COS) Ph.D. program. Topics include: Voting history and administration, vote buying, election rigging, punched cards, optical scanning, DRE machines, paper trails & Internet voting.

17-413 Software Engineering Reflection
Fall: 6 units
This course is an opportunity to reflect on a software engineering experience you have had in industry. It is structured as a writers workshop, in which you will work with the instructor and other students to identify and flesh out a software engineering theme that is illustrated by your industry experience. You will prepare a 10-page report on this theme, comparable to a practitioner's report at a conference like ICSE or OOPSLA, and a 30-minute presentation to match. This course fulfills a requirement of the Software Engineering Minor program, but students in other programs may take the course if they meet the prerequisite industry experience and if space is available.

17-607 Predictable Professional Performance
Intermittent: 9 units
The student will learn to apply the disciplined concepts introduced in PSP by using an agile cyclic development method to create a GUI-based application. While developing the product the student will work in teams to reinforce data collection through a series of ten increments and will learn to estimate using their own data as well as the data of other engineers and will learn to use those estimates to improve their project work. The student will learn how to move quickly through development cycles and will be introduced to shorthand notations for design, learn more about various techniques for development in practice, and will explore technology adoption issues. A special focus will be made on continuous risk management and a more disciplined approach to the capture, analyzing, and making decisions by means of statistical methods. All the techniques, developed interactively with the students, will reinforce the basic concepts from PSP and TSP, but will allow the student to further evaluate their processes and to use the processes in a disciplined team environment with a well understood data collection method. The course will culminate with the student evaluating their own performance as a team member and as a developer in a final report. This course will both reinforce and develop the concepts from PSP and TSP so no prerequisite for either of these courses is needed other than software programming skills producing standalone GUI applications in Java.

17-634 SE Elective
Intermittent
The goal of this course is to provide an understanding of electronics for students with formal backgrounds in computer science and software engineering to prepare them for work in domains where hardware and software are closely coupled. Example domains include: robotics, avionics, automotive, mobile devices, network switching systems, process/environmental controls, and many others. Throughout the course, students will have opportunities to experiment with hardware and software in hands-on exercises that include electronics labs, robotics, process control, and others. Prerequisites: A hardware background is not required, but students should have a solid computer science background that includes languages, data structures, operating systems, and basic computer organization. Real-world project experience is preferred, although academic project work or internships will suffice. Undergraduates are welcomed but instructor approval is required (tattanzo@cs.cmu.edu).

17-635 Software Measurement
Fall: 9 units
Sections D and PP are NOT available for on-campus students. The purpose of this course is to introduce students to software measurement — from need identification through analysis and feedback and into the process. Much of the course material demonstrates concepts of software measurement that are used by managers and practitioners in industry today. The course is taught within the framework of the software engineering process. Required text: Selected Readings handed out in class Requirement. This course is intended for individuals who have industrial software engineering experience with a large project, or a comprehensive undergraduate course in software engineering.

17-644 Very Large Information Systems
Fall: 12 units
In this course we cover the basic technology for very large information systems. We cover database and information retrieval file organization, indexes, centralized query processing, concurrency control and serializability theory for transactions. We then consider parallel query processing, distributed query processing, distributed transaction processing, and replication. In the latter part of the course we examine the basics of data warehousing, data mining, publish-subscribe processing, and personal information management. Course material is based on lectures, textbooks, and articles in the literature. Assignments consist of homework, small programming assignments, quizzes and exams. At the end of the course, the student will have a good understanding of the fundamental algorithms used in a broad set of areas of information systems.
17-651 Models of Software Systems
Fall: 12 units
Scientific foundations for software engineering depend on the use of precise, abstract models for describing and reasoning about properties of software systems. This course considers a variety of standard models for representing sequential and concurrent systems, such as state machines, algebras, and traces. It shows how different logics can be used to specify properties of systems, such as functional correctness, deadlock freedom, and internal consistency. Concepts such as compositionality, abstraction, invariants, non-determinism, and inductive definitions are recurrent themes throughout the course. After completing this course, students will: 1. Understand the strengths and weaknesses of certain models and logics for representing state machines, algebraic and process models, and temporal logic; 2. Be able to select and describe appropriate abstract formal models for certain classes of systems, describe abstraction relations between different levels of description, and reason about the correctness of refinements; 3. Be able to prove elementary properties about systems described by the models introduced in the course; and 4. Understand some of the strengths and weaknesses of formal automated reasoning tools. Prerequisites: Undergraduate discrete math including first-order logic, sets, functions, relations, and simple proof techniques such as induction. Sections D, PP and G are NOT available for on-campus students. Admission to the class is by approval from the instructor: If you are not MSE/MSIT-SE/MITs, send email to <garlan@cs.cmu.edu> for permission to enroll. The email should briefly describe your background, whether you have taken an undergraduate discrete math course, and why you would like to take the course. The course must be taken for a letter grade (not pass/fail). This is a graduate course. Only undergraduate SE minors may take this course.

17-652 Methods: Deciding What to Design
Fall: 12 units
Sections D and PP are NOT available for on-campus students. Practical development of software requires an understanding of successful methods for bridging the gap between a problem to be solved and a working software system. In this course you will study a variety of ways of understanding the problem to be solved by the system you’re developing and of framing an appropriate solution to that problem. After completing this course, you will be able to: 1. Identify different classes of problems and structures and analyze technical, organizational, usability, business, and marketing constraints on solutions; 2. Apply engineering approaches to frame solutions; 3. Understand how your understanding of the problem should be reflected in the software design; 4. Minimum of 3 months hands-on software development experience in industry. Students not accepted into the MSE program must present a current resume showing relevant industrial experience to department coordinator. This course is offered to only MSE/MITs and MSIT-SE students for fall semester. This course is for graduate students only. This course is for letter grade only (no pass/fail grades). To register for Methods course, you will need to have taken at least 3 MOS hands-on software development experience in industry. Please submit a statement that gives the company, the dates, and a sentence or two about what you were actually doing during that time (i.e. programming, testing, other things actually involved in software engineering). This is a graduate course. Only undergraduate SE minors may take this course.

17-653 Managing Software Development
Fall: 12 units
Sections D, F, PP and G are NOT available for on-campus students. Large scale software development requires the ability to manage resources - both human and computational - through control of the development process. This course provides the knowledge and skills necessary to lead a project team, understand the relationship of software development to overall product engineering, estimate time and costs, and understand the software process. After completing this course, students will: 1. Be able to write a software project management plan, addressing issues of risk analysis and schedule, costs, team organization, resources, and technical approach 2. Be able to define the key process areas of the Capability Maturity Model and the technology and practices associated with each and a variety of software development life cycle models and explain the strengths, weaknesses, and applicability of each 3. Understand the relationship between software products and overall products (if embedded), or the role of the product in the organizational product line 4. Understand the legal issues involved in liability, warranty, patentability, and copyright 5. Understand the purpose and limitations of software development standards and be able to apply sensible tailoring where needed 6. Be able to use software development standards for documentation and implementation 7. Be able to apply leadership principles 8. Be able to perform requirements analysis 9. Be able to understand and use software process models A student must have had industrial software engineering experience with a large project, or a comprehensive undergraduate course in software engineering. This course is for graduate students only. This course is for letter grade only. Contact the instructor for permission to join the class. This is a graduate course. Only undergraduate SE minors may take this course.

17-654 Analysis of Software Artifacts
Spring: 12 units
This is the systematic examination of an artifact to determine its properties. This course will focus on analysis of software artifacts - primarily code, but also including analysis of designs, architectures, and test suites. We will focus on functional properties, but also cover non-functional properties like performance and security. In order to illustrate core analysis concepts in some depth, the course will center on static program analysis, but also include a breadth of techniques such as testing, model checking, theorem proving, dynamic analysis, and type systems. The course will balance theoretical discussions with lab exercises in which students will apply the ideas they are learning to real artifacts. After completing this course, students will: 1. Know what kinds of analyses are available and how to use them * understand their scope and power, when they can be applied and what conclusions can be drawn from their results * have a grasp of fundamental notions sufficient to evaluate new kinds of analysis when they are developed * have some experience selecting and writing analyses for a real piece of software, applying them and interpreting the results Ph.D. students taking the 17-754 version of the course will gain a broad overview of the analysis research literature and in-depth knowledge of a particular sub-area through a course project. Requirement: A recent discrete math course and programming experience. Strongly Recommended: Models of SW Development course (17-651) before taking this course. This course is for letter grade only (no pass/fail grades). This is a graduate course. Only undergraduate SE minors may take this course with the instructor’s permission.

17-655 Architectures for Software Systems
Spring: 12 units
Successful design of complex software systems requires the ability to describe, evaluate, and create systems at an architectural level of abstraction. This course introduces architectural design of complex software systems. The course considers commonly-used software system structures, techniques for designing and implementing these structures, models and formal notations for characterizing and reasoning about architectures, tools for generating specific instances of an architecture, and case studies of actual system architectures. It teaches the skills and background students need to evaluate the architectures of existing systems and to design new systems in principled ways using well-founded architectural paradigms. After completing this course, students will be able to: 1. Describe an architecture accurately 2. Recognize major architectural styles in existing software systems 3. Generate architectural alternatives for a problem and choose among them 4. Construct a medium-sized software system that satisfies an architectural specification 5. Use existing definitions and development tools to expedite such tasks 6. Understand the formal definition of a number of architectures and be able to reason about the properties of those architectures 7. Use domain knowledge to specialize an architecture for a particular family of applications REQUIREMENT: Experience with at least one large software system, either through industrial software development experience or an undergraduate course in software engineering, compilers, operating sys., or the like. This course is for letter grade only. Instructor wants each student who wants to take this class to have worked on a significant software system in your courses or in industry. Write to <garlan@cs.cmu.edu> for admission into the course stating the experience you have had. This is a graduate course. Only undergraduate SE minors may take this course.

17-690 Seminar in Software Process
Intermittent
The Seminar in Software Process course is a self-study and discussion course. Discussions center on how to implement effective and efficient software processes. The focus of the seminar is on systematic approaches to building software better, faster, and cheaper. A variety of process improvement and quality management strategies are discussed, including Total Quality Management, Baldrige Award, ISO 9001, ISO 15504 (SPICE), and others, but the course is primarily structured around the staged approach to improvement from the Capability Maturity Model (CMM). Specific topics that are covered included software project management, configuration management, quality assurance, organizational learning, process definition, training, peer reviews, team building, change management, measurement, and statistical process control. These topics are addressed from a process management perspective. Required Textbook: M.B. Chrissis, M.D. Konrad, and S. Shrum, “CMMI: Guidelines for Process Integration and Product Improvement, Second Edition,” Addison-Wesley, 2006, or you can use the online SEI technical reports, which are free. Note that the third edition of the book is out of print and is out of stock. This is a graduate course. Only undergraduate SE minors may take this course.
17-803 Electronic Voting
Fall: 12 units
After the punched-card disaster in Florida in 2000, the U.S. has been rushing to replace old voting equipment with direct-recording electronic (DRE) machines (sometimes incorrectly lumped together as “touchscreens”). Recent examination of these machines by computer security experts has revealed significant security vulnerabilities, leading to a call by some computer scientists to either discontinue use of such machines or equip them with a printing device that would enable the voter to see a paper record of how she had voted before leaving the voting booth. This “voter-verifiable paper trail” idea has polarized the voting community, leading to bills in Congress and in some states to require it but with donors, election officials and public advocacy groups strongly in opposition. Each meeting will be devoted to a technical lecture followed by an hour of general discussion. The course is open to juniors, seniors and graduate students. Students from outside SCS are welcome. No advanced technical background is required except for some security and cryptography topics. Each student will participate in a team project, with a presentation to be made on the last day of the course. Grading will be based on class participation, the project paper and a final exam. There will be assigned readings but no midterm or written homework. This course counts as an elective in the Computation, Organizations and Society (COS) Ph.D. program. Topics include: Voting history and administration, vote buying, election rigging, punched cards, optical scanning, DRE machines, paper trails & Internet voting.

Statistics Courses

36-149 Statistics Freshman Seminar
Fall and Spring: 9 units
Networks: Where do they come from? What do they tell us? Thirty years ago, the word “network” was mostly used in reference to computers or television broadcasting channels. Now we have networks of friends, enemies, phones, stars, tweets, international governments, terrorists, etc. Where do these networks come from? How are they built? What do they represent? As we learn more about how everything is connected, we also face challenges in trying to understand the data that a network can generate. In this course, you’ll learn about networks from a New England monastery facing a political crisis to social groups of friends (is obesity contagious? what about divorce?) to 15th century marriages among prominent Italian families to international political disputes and skirmishes (is the enemy of my enemy my friend?) to the spread of HIV among intravenous drug users. Along the way, we'll explore how to describe, visualize, analyze, and even break down the networks that surround us.

36-201 Statistical Reasoning and Practice
All Semesters: 9 units
This course will introduce students to the basic concepts, logic, and issues involved in statistical reasoning, as well as basic statistical methods used to analyze data and evaluate studies. The major topics to be covered include methods for exploratory data analysis, an introduction to research methods, elementary probability, and methods for statistical inference. The objectives of this course are to help students develop a critical approach to the evaluation of study designs, data and results, and to develop skills in the application of basic statistical methods in empirical research. An important feature of the course will be the use of the computer to facilitate the understanding of important statistical ideas and for the implementation of data analysis. In addition to three lectures a week, students will attend a computer lab once a week. Examples will be drawn from areas of particular interest to H&SS students. Not open to students who have received credit for 36-202, 36-626. Cross-listed as 70-156.

36-202 Statistical Methods
Spring: 9 units
This course builds on the principles and methods of statistical reasoning developed in 36-201 (or its equivalents). The course covers simple and multiple regression, analysis of variance methods and logistic regression. Other topics may include non-parametric methods and probability models, as time permits. The objectives of this course is to develop the skills of applying the basic principles and methods that underlie statistical practice and empirical research. In addition to three lectures a week, students attend a computer lab once a week for “hands-on” practice of the material covered in lecture. Not open to students who have received credit for: 36-202/70-202, 36-208, 36-309.
Prerequisites: 36-201 or 36-207 or 36-220 or 36-247 or 70-207.

36-207 Probability and Statistics for Business Applications
Fall: 9 units
This is the first half of a year long sequence in basic statistical methods that are used in business and management. Topics include exploratory and descriptive techniques, probability theory, statistical inference in simple settings, basic categorical analysis, and statistical methods for quality control. Not open to students who have received credit for 36-201, 36-220, 36-625, or 36-247. Cross-listed as 70-207.
Prerequisites: 21-112 or 21-120 or 21-121.

36-208 Regression Analysis
Spring: 9 units
This is the second half of a year long sequence in basic statistical methods that are used in business and management. Topics include time series, regression and forecasting. In addition to two lectures a week, students will attend a computer lab once a week. Not open to students who have received credit for 36-202, 36-626. Cross-listed as 70-208.
Prerequisites: (21-120 or 21-121 or 21-112) and (36-207 or 70-207 or 36-201 or 36-220 or 36-247).

36-217 Probability Theory and Random Processes
All Semesters: 9 units
This course provides an introduction to probability theory. It is designed for students in electrical and computer engineering. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, limit theorems, and an introduction to random processes. Some elementary ideas in spectral analysis and information theory will be given. A grade of C or better is required in order to use this course as a pre-requisite for 36-226 and 36-410. Not open to students who have received credit for 36-225, or 36-625.
Prerequisites: 21-112 or 21-122 or 21-123 or 21-256 or 21-259.

36-220 Engineering Statistics and Quality Control
All Semesters: 9 units
This is a course in introductory statistics for engineers with emphasis on modern product improvement techniques. Besides exploratory data analysis, basic probability, distribution theory and statistical inference, special topics include experimental design, regression, control charts and acceptance sampling. Not open to students who have received credit for 36-201, 36-207/70-207, 36-226, 36-626, or 36-247, except when AP credit is awarded for 36-201.
Prerequisites: 21-112 or 21-120 or 21-121.

36-225 Introduction to Probability Theory
Fall: 9 units
This course is the first half of a year long course which provides an introduction to probability and mathematical statistics. The use of probability theory is illustrated with examples drawn from engineering, the sciences, and management. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, law of large numbers, and the central limit theorem. A grade of C or better is required in order to advance to 36-226 and 36-410. Not open to students who have received credit for 36-217 or 36-625.
Prerequisites: 21-256 or 21-259.

36-226 Introduction to Statistical Inference
Spring: 9 units
This course is the second half of a year long course in probability and mathematical statistics. Topics include maximum likelihood estimation, confidence intervals, and hypothesis testing. If time permits there will also be a discussion of linear regression and the analysis of variance. A grade of C or better is required in order to advance to 36-401, 36-402 or any 36-46x course. Not open to students who have received credit for 36-626.
Prerequisites: 15-359 or 21-325 or 36-217 or 36-225.

36-247 Statistics for Lab Sciences
Spring: 9 units
This course is a single-semester comprehensive introduction to statistical analysis of data for students in biology and chemistry. Topics include exploratory data analysis, elements of computer programming for statistics, basic concepts of probability, statistical inference, and curve fitting. In addition to two lectures, students attend a computer lab each week. Not open to students who have received credit for 36-201, 36-207/70-207, 36-220, or 36-246.
Prerequisites: 21-112 or 21-120 or 21-121.
36-303 Sampling, Survey and Society
Spring: 9 units
This course will revolve around the role of sampling and sample surveys in the context of U.S. society and its institutions. We will examine the evolution of survey taking in the United States in the context of its economic, social and political uses. This will eventually lead to discussions about the accuracy and relevance of survey responses, especially in light of various kinds of nonsampling error. Students will be required to design, implement and analyze a survey sample.
Prerequisites: 36-202 or 36-208 or 36-226 or 36-309 or 36-625 or 70-208 or 73-261 or 88-250.

36-309 Experimental Design for Behavioral and Social Sciences
Fall: 9 units
Statistical aspects of the design and analysis of planned experiments are studied in this course. A clear statement of the experimental factors will be emphasized. The design aspect will concentrate on choice of models, sample size and order of experimentation. The analysis phase will cover data collection and computation, especially analysis of variance and will stress the interpretation of results. In addition to a weekly lecture, students will attend a computer lab once a week.
Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-247.

36-315 Statistical Graphics and Visualization
Spring: 9 units
Graphical displays of quantitative information take on many forms as they help us understand both data and models. This course will serve to introduce the student to the most common forms of graphical displays and their uses and misuses. Students will learn both how to create these displays and how to understand them. As time permits the course will consider some more advanced graphical methods such as computer-generated animations. Each student will be required to engage in a project using graphical methods to understand data collected from a real scientific or engineering experiment. In addition to two weekly lectures there will be lab sessions where the students learn to use software to aid in the production of appropriate graphical displays.
Prerequisites: 36-202 or 36-208 or 36-226 or 36-303 or 36-309 or 36-625 or 70-208 or 88-250.

36-350 Statistical Computing
Fall: 9 units
Statistical Computing: An introduction to computing targeted at statistics majors with minimal programming knowledge. The main topics are core ideas of programming (functions, objects, data structures, flow control, input and output, debugging, logical design and abstraction), illustrated through key statistical topics (exploratory data analysis, basic optimization, linear models, graphics, and simulation). The class will be taught in the R language. No previous programming experience required. Pre-requisites: (36-202 or 36-208), plus ("computing at Carnegie Mellon" or consent of instructor).
Prerequisites: 36-202 or 36-208 or 70-208.

36-401 Modern Regression
Fall: 9 units
This course is an introduction to the real world of statistics and data analysis. We will explore real data sets, examine various models for the data, assess the validity of their assumptions, and determine which conclusions we can make (if any). Data analysis is a bit of an art; there may be several valid approaches. We will strongly emphasize the importance of critical thinking about the data and the question of interest. Our overall goal is to use a basic set of modeling tools to explore and analyze data and to present the results in a scientific report. A minimum grade of C in any one of the pre-requisites is required. A grade of C is required to move on to 36-402 or any 36-46x course.
Prerequisites: (36-226 or 36-625 or 73-407 or 36-310) and (21-240 or 21-241).

36-402 Advanced Data Analysis
Spring: 9 units
This course introduces modern methods of data analysis, building on the theory and application of linear models from 36-401. Topics include nonlinear regression, nonparametric smoothing, density estimation, generalized linear and generalized additive models, simulation and predictive model-checking, cross-validation, bootstrap uncertainty estimation, multivariate methods including factor analysis and mixture models, and graphical models and causal inference. Students will analyze real-world data from a range of fields, coding small programs and writing reports.
Prerequisites: 36-401.
Prerequisite: 36-401.
36-625 Probability and Mathematical Statistics I
Fall: 12 units
This course is a rigorous introduction to the mathematical theory of probability, and it provides the necessary background for the study of mathematical statistics and probability modeling. A good working knowledge of calculus is required. Topics include combinatorial analysis, conditional probability, generating functions, sampling distributions, law of large numbers, and the central limit theorem. Students studying Computer Science, or considering graduate work in Statistics or Operations Research, should carefully consider taking this course instead of 36-225 after consultation with their advisor. Not open to students who have received credit for 36-217 or 36-225. Prerequisite: 21-122 and 21-241 and (21-256 or 21-259). Prerequisites: 21-118 or 21-122 or 21-123 or 21-256.

Tepper School of Business Courses

45-816 Studies in Financial Engineering
Fall: 6 units
This course is about using financial engineering and derivative securities to solve practical business problems. Students will work through business cases and give in-class simulated sales pitches to hypothetical clients. The cases highlight the design, valuation and hedging of structured products on stock prices, interest rates, FX, and exotic “underlyings” such as volatility, credit, and energy. Reference text: Hull, J., Option, Futures and Other Derivative Securities, 2nd edition, Prentice-Hall, 1993.