
Carnegie Mellon University

Undergraduate Catalog 2010-2012

Carnegie Institute of Technology

The College of Fine Arts

The 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

Carnegie Mellon University does not discriminate and Carnegie Mellon University is required not to discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex or handicap in violation of Title VI of the Civil Rights Act of 1964, Title IX of the Educational Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973 or other federal, state, or local laws or executive orders.

In addition, Carnegie Mellon University does not discriminate in admission, employment, or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or gender identity. Carnegie Mellon does not discriminate in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Presidential Executive Order directing the Department of Defense to follow a policy of Don't ask, don't tell, don't pursue excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-6684 or the Vice President for Campus Affairs, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-2056. Carnegie Mellon University publishes an annual campus security report describing the university's security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The security report is also available online.

Obtain general information about Carnegie Mellon University by calling 412-268-2000.

Foreword

This catalogue 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 catalogue is current as of August, 2010, with an addendum to be provided in August, 2011, to update with changes in University academic programs, policies and services. 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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Look at Carnegie Mellon

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, redefining fields of knowledge, pushing their own visions of the possible and contributing to the world around them," writes Jared L. Cohon, 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 their 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 institution 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 the two 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, 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 can 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 understand 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 perspective 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 megamarts 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 alumnus 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. Most major symphonies around the country include Carnegie Mellon alumni. The university's graduates are also prominent in government, and include a former White House staff assistant, a U.N. delegate and a former first deputy chairman of the presidium of the USSR. An astronaut who walked on the moon holds a Carnegie Mellon degree, as does the project director of NASA's Pioneer Interplanetary Probe. Five Carnegie Mellon alumni have gone on to win the Nobel Prize (three in economics, two in physics), and the works of many former art students hang in the permanent collections of more than 50 international museums.

Our Vision

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 teaching 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.

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- 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

Carnegie Institute of Technology

Interdepartmental

- M.S. in Engineering and Technology Innovation Management

Biomedical Engineering

- B.S. in an engineering discipline and Biomedical Engineering
- M. of Biomedical Engineering
- M.S. in Biomedical Engineering
- Ph.D. in Biomedical Engineering

Chemical Engineering

- B.S. in Chemical Engineering
- 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
- M.S. in Advanced Infrastructure Systems
- M.S. in Architecture-Engineering-Construction Management (jointly with the Department of Architecture)
- 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 Computational Science and Engineering
- M.S. in Environmental Engineering
- M.S. in Environmental Management and Science
- Ph.D. in Advanced Infrastructure Systems
- Ph.D. in Architecture-Engineering-Construction Management (jointly with the Department of Architecture)
- Ph.D. in Environmental Engineering
- Ph.D. in Civil and Environmental Engineering/Engineering and Public Policy
- Ph.D. in Civil Engineering
- Ph.D. in Computational Mechanics
- Ph.D. in Computational Science and Engineering
- Ph.D. in Environmental Management and Science

Electrical and Computer Engineering

- B.S. in Electrical and Computer Engineering
- 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
- 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
- M.S. in Mechanical Engineering
- M. of Product Development (jointly with the School of Design)
- Ph.D. in Mechanical Engineering

Materials Science and Engineering

- B.S. in Materials Science and Engineering
- 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

Interdepartmental

- M. of Arts Management (jointly with the Heinz College)

Architecture

- B.Arch in Architecture (5 year program)
- M.S. in Architecture
- M.S. in Architecture-Engineering-Construction Management (jointly with the Department of Civil and Environmental Engineering)
- 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 Architecture-Engineering-Construction Management
- Ph.D. in Building Performance and Diagnostics
- Ph.D. in Computational Design

Art

- B.F.A. in Art
- M.F.A. in Art

Design

- B.F.A. in Communication Design
- B.F.A. in Industrial Design
- M. Design in Interaction Design
- M. Design in Communication Planning and Information Design (jointly with Department of English)
- M. of Product Development (jointly with Department of Mechanical Engineering)
- Ph.D. in Design

Drama

- B.F.A. in Drama
- M.F.A. in Costume Design
- M.F.A. in Directing
- M.F.A. in Directing and Playwriting
- M.F.A. in Drama
- M.F.A. in Dramatic Writing
- M.F.A. in Lighting Design
- M.F.A. in Production
- 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
- B.F.A. in Music (Composition) B.F.A. in Music Performance
- B.S. in Music and Technology (jointly with the Department of

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- Electrical and Computer Engineering and the School of Computer Science)
- M. Music in Composition
- M. Music in Conducting
- M. Music in Music Education
- M. Music in Music Performance
- M.S. in Music and Technology (jointly with the Department of Electrical and Computer Engineering and the School of Computer Science)

College of Humanities and Social Sciences

Interdepartmental

- B.S. in Economics and Statistics (jointly offered by the Department of Statistics and Tepper School of Business)
- B.A. in Ethics, History, and Public Policy (jointly offered by the Departments of History and Philosophy)
- B.A. in European Studies (jointly offered by the Departments of Modern Languages and History)
- B.S. in Ethics, History, and Public Policy (jointly offered by the Departments of History and Philosophy)
- B.S. in Information Systems
- B.A. in Linguistics (jointly offered by the Departments of English, Modern Languages, Philosophy, and Psychology)

Center for the Neural Basis of Cognition

- Ph.D. in Neural Computation

Economics (jointly offered by H&SS and Tepper unless otherwise noted)

- B.A. in Economics
- B.S. in Economics
- B.S. in Economics and Mathematical Sciences (jointly offered by the College of Humanities and Social Sciences, the Department of Mathematical Sciences, and Tepper School of Business)
- B.S. in Economics and Statistics (jointly offered by the Tepper School of Business and the Department of Statistics)
- 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
- B.A. in English
- B.A. in Professional Writing
- B.S. in Technical Writing and Communication
- M.A. in Literary and Cultural Studies
- M.A. in Professional Writing
- M.A. in Rhetoric
- M. of Communication Planning and Information Design (jointly with the School of Design)
- Ph.D. in Literary and Cultural Studies
- Ph.D. in Rhetoric

History

- B.A. in History
- B.A. in Ethics, History, and Public Policy (jointly with the Department of Philosophy)
- B.A. in Global Studies
- B.S. in Ethics, History, and Public Policy (jointly with the Department of Philosophy)
- M.A. in History
- M.A. in History (fifth-year program along with Chatham College Secondary School Pennsylvania State Teacher Certification Program)
- M.S. in History and Policy
- Ph.D. in History
- Ph.D. in History and Policy

Modern Languages

- B.A. in Chinese Studies
- B.A. in French and Francophone Studies
- B.A. in German Studies

- B.A. in Hispanic Studies
- B.A. in Japanese Studies
- B.A. in Russian Studies
- Ph.D. in Second Language Acquisition

Philosophy

- B.A. in Philosophy
- B.A./B.S. in Ethics, History, and Public Policy (jointly with the Department of History)
- B.S. in Logic and Computation
- M.A. in Philosophy
- M.S. in Logic, Computation and Methodology
- Ph.D. in Logic, Computation and Methodology

Psychology

- B.A. in Psychology
- B.S. in Cognitive Science
- B.S. in Psychology
- B.S. in Psychology and Biological Sciences (jointly with the Department of Biological Sciences) Ph.D. in Psychology

Social and Decision Sciences

- B.S. in Decision Science
- B.S. in International Relations and Politics
- B.S. in Policy and Management
- M.S. in Behavioral Decision Research
- M.S. in Political Science
- M.S. in Psychology and Behavioral Decision Research (jointly with the Department of Psychology)
- M.S. in Social and Decision Sciences
- Ph.D. in Behavioral Decision Research
- Ph.D. in Political Science
- Ph.D. in Psychology and Behavioral Decision Research (jointly with the Department of Psychology)
- Ph.D. in Social and Decision Sciences
- Ph.D. in Sociology

Statistics

- B.S. in Economics and Statistics (jointly with the Department of Economics)
- B.S. in Statistics
- M. of Statistical Practices
- M.S. in Statistics
- Ph.D. in Statistics
- Ph.D. in Statistics and Information Systems
- 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)

Computer Science and Arts

- B. of Computer Science and Arts (jointly with the School of Computer Science and the College of Fine Arts)

Computational Biology

- M.S. in Computational Biology

Entertainment Technology Center

- M. of Entertainment Technology

H. John Heinz III College

- M. of Arts Management (jointly with the College of Fine Arts)
- M. of Entertainment Industry Management (jointly with the College of Fine Arts)
- M. of Medical Management
- M. of Public Management

- M.S. in Biotechnology Management (jointly with Mellon College of Science and Tepper School of Business)
- M.S. in Educational Technology Management
- M.S. in Health Care Policy and Management
- M.S. in Information Security Policy and Management
- M.S. in Public Policy and Management
- Ph.D. in Public Policy and Management
- Ph.D. in Economics and Public Policy (jointly with the Tepper School of Business)
- Ph.D. in Statistics and Public Policy (jointly with College of Humanities and Social Sciences)

Humanities and Arts

- B. of Humanities and Arts (jointly with the College of Humanities and Social Sciences and the College of Fine Arts)

Information Systems

- M. of Information Systems 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)

Mellon College of Science

Biological Sciences

- B.A. in Biological Sciences (and a discipline the Humanities and Social Sciences)
- B.S. in Biological Sciences
- B.S. in Biological Sciences and Psychology (jointly with the Department of Psychology)
- B.S. in Computational Biology
- M.S. in Biological Sciences
- M.S. in Computational Biology
- Ph.D. in Biological Sciences

Chemistry

- B.A. in Chemistry
- B.S. in Chemistry
- B.S. in Chemistry/Computational Chemistry Track
- 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
- B.S. in Computational Finance (jointly with Heinz College)
- M.S. in Computational Finance (jointly with Heinz College)
- 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
- B.S. in Physics
- M.S. in Physics
- Ph.D. in Applied Physics
- Ph.D. in Physics

School of Computer Science

Computer Science

- B.S. in Computer Science
- B.S. in Music and Technology (jointly with the Departments of Electrical and Computer Engineering and Music)
- 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 Information Technology -- eBusiness Technology
- M.S. in Information Technology - Very Large Information Systems
- M.S. in Computation, Organizations and Society
- Ph.D. in Computation, Organizations and Society

Language Technologies Institute

- M.S. in Language Technologies
- 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
- Ph.D. in Robotics

Software Engineering

- M. of Software Engineering
- M.S. in Information Technology
- M.S. in Information Technology (Software Engineering)
- M.S. in Software Engineering
- Ph.D. in Software Engineering

Science and Arts

- B. of Science and Arts (jointly with the College of Fine Arts and the Mellon College of Science)

Science and Humanities Scholars

- B.A./B.S. in various disciplines (jointly with the College of Humanities and Social Sciences and the Mellon College of Science)

David A. Tepper School of Business

- B.A. in Economics
- B.S. in Economics
- B.S. in Economics and Mathematical Sciences (jointly offered by the College of Humanities and Social Sciences, the Department of Mathematical Sciences, and Tepper School of Business)
- B.S. in Economics and Statistics (jointly offered by the Tepper School of Business and the Department of Statistics)
- B.S. in Business Administration
- M.B.A. in Business Administration
- M.B.A./M.S.C.F in Business Management and Computational Finance (jointly with the College of Humanities and Social Sciences, 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 Information Networking (jointly with the Carnegie Institute of Technology and the School of Computer Science)
- 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)

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Undergraduate Admission

Michael A. Steidel, Director of Admission
Office: Warner Hall, Admission Lobby, First Floor

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 will be either the main factor or a significant 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. It is recommended that students applying to the School of Architecture will have to complete an online questionnaire and have the option to submit creative work for review, in addition to having their academic performance evaluated.

Candidates for the Carnegie Institute of Technology, the Mellon College of Science, and the School of Computer Science will be evaluated on the basis of academic performance, and we will look additionally for strength in mathematics and science. Academic performance is also the main criteria we use to evaluate applicants to the College of Humanities and Social Sciences, the Information Systems program and to the Tepper School of Business' undergraduate program. In these cases, we emphasize reading and comprehension abilities as well as mathematics courses.

No one single grade, factor or score will automatically grant or deny a student admission to Carnegie Mellon. Students should be aware of all the admission requirements-secondary school preparation,

standardized test requirements, nonacademic information, counselor, teacher and interview recommendations-when submitting applications. We will use the sum total of these different factors when making our admission decisions. Because we want to have a sense of who the student is as a person, we look closely at the essay and personal statement the student is asked to write, the guidance counselor's evaluation and the teacher's recommendation.

Freshman Application Instructions

Carnegie Mellon uses the Common Application exclusively. Before your Common Application will be processed, you must submit the Carnegie Mellon Common Application Supplement.

1. Apply for admission only to the specific college(s) in which you are interested. If applying to more than one college or 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)
 - College of Humanities and Social Sciences (H&SS)
 - 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"
 - Bachelor of Science and Arts (BSA) - see "BXA Intercollege Degree Programs"
 - Bachelor of Computer Science and Arts (BCSA) - see "BXA Intercollege Degree Programs"

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 reserving your audition online at www.cmu.edu/admission/finenarts.
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 that an official CEEB 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 number 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 600 or better on the pencil and paper TOEFL, 100 or better on the IBT TOEFL, and an IELTS scores of 7.5 or above.
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 encouraged to complete an online questionnaire and submit a portfolio of creative work. Please go to www.cmu.edu/admission/finearts for further information. The School of Drama requires that students apply to the university and obtain their Admission ID 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, voice, or the BHA/BSA/BCSA 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. Once your Common Application and Supplement are processed, a letter confirming the receipt of your application will be sent to the mailing address listed on your application. If you do not receive this confirmation letter six weeks from the date you mailed your application, please contact the Office of Admission at (412) 268-2082.
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 decisions 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 expect 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, and BHA/BSA/BCSA. Early Decision II is available to all programs, with the exception of architecture, art, design, drama, music or BHA/BSA/BCSA.

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.
 - CIT, H&SS, 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
 - CFA:
 - 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 either a printed catalog, with your name and highlighted course descriptions from each college/university attended, or links to your college's online catalog/specific courses within the catalog. **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. Sign the "Confidentiality Statement" on the Secondary School Report. Give this form and your completed application for admission to a dean or an advisor at the college you attended (or are currently attending). Your dean or advisor should complete and return the form and application directly to the Office of Admission. **IMPORTANT:** Carnegie Mellon prefers that all forms and documents be submitted at the same time. If they must be sent separately, make sure to print your full name and social security number at the top of each document.
6. Transfer application deadlines are as follows:
 - Spring transfer: October
 - Fall transfer: March 1 (December 1 for CFA 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 CSS Profile at <https://profileonline.collegeboard.com> and submit signed copies of parent and student tax documents. See <http://www.cmu.edu/admission> for more details.

If planning on:	File FAFSA by this date:
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 at 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, H&SS, 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 returned 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. Sometimes transfer students have to take specific courses and accumulate a larger total number of credits than the normal amount required for graduation. The time it takes for you to graduate will depend on the time you need to complete the full university degree requirements - not on class standing at a previous institution.

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 H&SS 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 600 or better on the pencil and paper TOEFL, 100 or better on the IBT TOEFL or an IELTFS score of 7.5 and above. Please arrange to have these scores sent no later than January 1.

Advanced Placement Consideration

CEEB Advanced Placement Program

Carnegie Mellon recognizes the CEEB 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 deans 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.

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 or the School of Computer Science. 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 College of Humanities and Social Sciences (H&SS). To be considered for the BHA program, a student must apply and be admitted to both CFA and H&SS (you must check the CFA box and H&SS 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.

With the BHA/BSA/BCSA programs, you must include with your application a statement of intent (essay) describing your interdisciplinary goals in both academic areas and how the BHA/BSA/BCSA program would provide the opportunity and framework for you to accomplish these objectives. This essay is a central component in the selection process. The BHA/BSA/BCSA statement of intent fulfills the essay requirement on the supplement. You do not need to complete 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 e-mail.

- 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. At Carnegie Mellon, we strongly recommend that you attend an information session or interview with a counselor from the Office of Admission while on campus. Our interviews are viewed as an information exchange—we want to get to know you, just as you may want to learn more about us! During the interview, you'll have the opportunity to ask questions about admission requirements, financial aid, student life, Pittsburgh—and much more!

If you'd like an interview, request an appointment at least three weeks prior to the date you're coming to campus. Interviews are available Monday through Friday throughout the summer and until mid-November. However, because we spend a great deal of time reviewing applications between January 1 and May 1, we do not conduct interviews during this time period. To schedule an information session or an interview, call 412-268-2082 on any weekday between 8:30 a.m. to 5 p.m. (EST).

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 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 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 afternoon 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 the dining facilities

18 Undergraduate Admission

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 admission staff will travel to various cities across the country this summer and fall to present a multimedia presentation in a large group setting. During the 90-minute program, you will learn about life on campus and in Pittsburgh, admission requirements, financial aid policies, and the many benefits of attending Carnegie Mellon. While the program is presented by an admission counselor, you will hear from students, alumni, and advocates of the university 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 Action Program

The Advanced Placement Early Admission (APEA) Program is a challenging summer program intended for high school students who want to enrich their educational experience by taking college classes identical to those that a Carnegie Mellon undergraduate student would take. The program is designed for mature, motivated students who seek to gain college credit and who are eager to sample college life early by living in a residence hall and participating in educational, social, and recreational activities.

Each summer the faculty, who teach at the university during the fall and spring, offer approximately three dozen courses from across the university in the natural sciences, mathematics, social sciences, humanities, engineering, computer science, and the arts. During the six-week program, resident students are required to choose two full courses with material that would otherwise be covered during a semester. The APEA summer course load is therefore roughly equivalent to a typical semester course load, allowing students to measure their abilities as college students.

APEA classes typically meet daily. Class sizes are kept small, giving students a personal environment in which to learn. Although a substantial amount of homework is inherent in the program, it will naturally vary from course to course and from student to student.

Students who complete two full courses in the APEA Program are exclusively eligible to apply to attend the university as degree students via the Early Action program. Under Early Action, students apply in September and receive a decision from the Admission Office in October. Those who are accepted can wait until the following April to decide whether to attend Carnegie Mellon. While successful

participation in the APEA Program does not guarantee admission, students in the APEA Program have historically a higher acceptance rate to the university.

Whether students are admitted early or not, the credit earned in the APEA Program and the experience gained can be an advantage. For students who eventually enter Carnegie Mellon, the six credits form a head start, but these credits are also accepted as college credit at other universities. In order not to prejudice any application for admission in the future, no record of marginal or failing work is released. In this regard, APEA provides students with a risk-free method to measure the extent to which they are prepared for college in general and Carnegie Mellon in particular.

Aside from its strong academic orientation, the APEA Program affords both residents and commuters many other opportunities for personal growth and development within a university setting.

The hard work, the independence, the pleasure of accomplishment, the interaction, the cultural and intellectual setting and, in a good way, the pressures of academic life, are combined in the APEA program to closely approximate the full rewards of a college experience.

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), evening presentations of artwork by the Pre-College Art faculty, a gallery exhibition of your artwork in the College of Fine Arts, a presentation by the Head of School to explain what a portfolio might contain for acceptance into the School of Art, weekly evening figure drawing

20 Summer Opportunities

sessions, an individual portfolio critique with a School of Art faculty member during the last week of the program and a personal interview with an Admissions Officer.

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.

The Summer Program has four main concentrations: Performance, Composition, Jazz Studies and Music Technology. Each student follows an individual schedule designed to meet specific needs and interests. Private lessons are mandated for every student, and a group of music support courses is common to all four areas. Students are encouraged to explore courses outside their area of concentration to insure comprehensive music training.

Applicants to the Summer Music Program should send a statement describing their past musical training, and a recent audio recording (CD preferred) of two selections, representative of their level of performance, or copies of original compositions, with the application materials.

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 six administrative departments: The HUB, University Registrar's Office, Student Financial Aid, Student Accounts Office, ID Card 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.

2010-2011 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.

Freshmen— Fall 2010

Per-unit tuition rate: \$576

	Resident	Commuter	Off-Campus
Tuition	\$41,500	\$41,500	\$41,500
Orientation Fee (Fall semester only)	196	196	196
Activity Fee	188	188	188
Port Authority Fee	92	92	92
Media Fee	10	10	10
Technology Fee	150	150	150
Room & Fees (2)	6,300	0	5,800
Dining (1,2)	4,450	1,870	4,140
Books & Supplies (4)	1,000	1,000	1,000
Personal/Misc. (4)	1,400	1,400	1,400
Transportation (4, 5)	0	660	0
Totals	\$55,286	\$47,066	\$54,476

Students who entered Fall 2008 and later

Per-unit tuition rate: \$576

	Resident	Commuter	Off-Campus
Tuition	\$41,500	\$41,500	\$41,500
Activity Fee	188	188	188
Port Authority Fee	92	92	92
Media Fee	10	10	10
Technology Fee	150	150	150
Room & Fees (2)	6,300	6,300	6,300
Dining (1,2,3)	4,140	1,870	4,140
Books & Supplies (4)	1,000	1,000	1,000
Personal/Misc. (4)	1,400	1,400	1,400
Transportation (4,5)	0	660	0
Totals	\$54,780	\$46,870	\$54,280

Students who entered Fall 2007

Per-unit tuition rate: \$566

	Resident	Commuter	Off-Campus
Tuition	\$40,740	\$40,740	\$40,740
Activity Fee	188	188	188
Port Authority Fee	92	92	92
Media Fee	10	10	10
Technology Fee	150	150	150
Room & Fees (2)	6,300	0	5,800
Dining (1,2,3)	4,140	1,870	4,140
Books & Supplies (4)	1,000	1,000	1,000
Personal/Misc. (4)	1,400	1,400	1,400
Transportation (4,5)	0	660	0
Totals	\$54,020	\$46,110	\$53,520

Students who entered Fall 2006

Per-unit tuition rate: \$545

	Resident	Commuter	Off-Campus
Tuition	\$39,222	\$39,222	\$39,222
Activity Fee	188	188	188
Port Authority Fee	92	92	92
Media Fee	10	10	10
Technology Fee	150	150	150
Room & Fees (2)	6,300	0	5,800
Dining (1,2,3)	4,140	1,870	4,140
Books & Supplies (4)	1,000	1,000	1,000
Personal/Misc. (4)	1,400	1,400	1,400
Transportation (4,5)	0	660	0
Totals	\$52,502	\$44,492	\$52,002

Students who entered Fall 2005 and prior

Per-unit tuition rate: \$527

	Resident	Commuter	Off-Campus
Tuition	\$37,930	\$37,930	\$37,930
Activity Fee	188	188	188
Port Authority Fee	92	92	92
Media Fee	10	10	10
Technology Fee	150	150	150
Room & Fees (2)	6,300	0	5,800
Dining (1,2,3)	4,140	1,870	4,140
Books & Supplies (4)	1,000	1,000	1,000
Personal/Misc. (4)	1,400	1,400	1,400
Transportation (4,5)	0	660	0
Totals	\$51,210	\$43,300	\$50,710

Footnotes:

¹ The commuter dining amount is based upon 14 meals per two weeks.

² Off-Campus room rate is resident room minus \$500. Off-Campus dining amount is resident dining minus \$310.

³ Non-freshman resident dining amount is freshman dining amount minus \$310.

⁴ These expenses will not appear on your Student Account Invoice.

⁵ Transportation for resident and off-campus students varies based on home state.

NOTE: In addition, minimal health insurance coverage is required at an estimated cost of \$1,065/year, unless a waiver is granted because you are covered under your family's health plan. Premium health insurance coverage is suggested for international students at an estimated cost of \$2,295/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

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, and registration and records. And, 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 HUB is Enrollment Services' student service center. If you have questions about any facet of your enrollment, you should contact an Assistant Director of Enrollment Services, in The HUB, Monday, Wednesday, and Friday between 8:30 a.m. and 4:30 p.m. or Tuesday or 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-registrars-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 settling their student 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 On-Line Registration (OLR).

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 on-line 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 on-line Schedule of Classes is provided on The HUB website. 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 the recommendation of the teaching 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 charges greater than those paid by the student at the time of fee settlement. After that time, no tuition adjustments will be made, with the exception of second minis for that particular semester.

For additional information, see the Tuition Assessment Policy in the University Policies section of this catalog

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.

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 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.

Satisfactory Academic Progress

The Department of Education requires recipients of Federal Title IV Financial Assistance to meet academic progress standards each year. Federal Title IV Financial Assistance includes the Federal Pell Grant, Federal Supplemental Educational Opportunity Grant, Federal Perkins Loan, Federal Work-Study, Federal Stafford Loan and Federal PLUS Loan Programs. Each university determines its own policy regarding sufficient progress standards. Federal academic progress standards must include two elements: cumulative QPA and cumulative units. At Carnegie Mellon, we define this as follows: first-year freshman students must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 1.75 cumulative QPA after the first year, all other students (excluding graduate students in the Tepper School of Business and Heinz) must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 2.00 cumulative QPA.

Outside Scholarships

Carnegie Mellon's policy regarding outside scholarships has changed effective for the 2010-2011 academic year.

If you receive outside scholarships, they will be used to meet your unmet financial need and where applicable, offset/reduce loans and workstudy.

Institutional grants and scholarships will not be reduced due to the receipt of outside scholarships unless one of the following conditions occur:

1. If you receive federal grants or loans, these funds, in combination with any outside scholarships, cannot exceed your financial need.
2. All outside scholarships, in combination with all aid received, cannot exceed your cost of attendance.

Outside scholarships are not from federal, state or institutional (school) sources, such as a Federal Pell Grant or SEOG. Examples of outside scholarships are: Coca Cola, Gates Millennium, Rotary scholarships, etc.

Students Pursuing a Second Bachelor's Degree

If you are enrolling in a second bachelor's degree program, you are not eligible for grants/scholarships. However, you may be eligible to receive funds from student loan and student employment programs. Eligibility for student loan funds is contingent upon the student's prior loan indebtedness.

Study Abroad

There are three ways to pay for study abroad at Carnegie Mellon: exchange programs (departmental or university-wide), sponsored study abroad, and external programs.

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 have eligibility 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 have eligibility 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 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, Plaid Ca\$h, 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 has been produced and is ready for viewing. 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 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 through Student Information Online. This service allows for flexibility in paying a current or future student account balance with an electronic debit from your U.S. checking or savings account. Payments can be scheduled up to 6 months in advance and can be modified at any point before the requested payment date. 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:

Carnegie Mellon
P.O. Box 360224
Pittsburgh, PA 15251-6224

Note: Do **not** include any additional correspondence with your payment. These payments are processed by a third party and will **not** be received by the Student Accounts Office.

Wire Transfer Payments

The following information is required to send a wire transfer payment:

Bank Name: Bank of New York Mellon
Bank Address: 500 Ross St., Pittsburgh, PA 15262
Routing Number: 043-000-261
Account Number: 197-9003
SWIFT Number: MELNUS3P
Reference: Student Name and Andrew ID

Carnegie Mellon is not responsible for wire transfer payments that are not properly identified. Allow at least 10-14 business days for processing. All unidentified wire transfers will be returned to sender. Please be sure to factor any banking fees charged by the originating bank into your payment amount to ensure that your student account is paid in full.

Tuition Payment Plan

The Carnegie Mellon Tuition Payment Plan administered by Tuition Management Systems (TMS) is recommended if you prefer to pay your educational costs in monthly installments. For an academic year plan, you are able to spread your payments out over 10 months. The plan offers a variety of other benefits, including life insurance, and is available for an annual fee. A semester option is available at a lower fee for those graduating in December or beginning their enrollment in the spring semester.

Benefits of the Carnegie Mellon Tuition Payment Plan include:

- Interest-free payments
- Life Insurance coverage for the bill payer
- 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
- 24-hour access to account information on a toll-free InfoLine

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. Any overpayments resulting from a monthly payment plan will be refunded in April.

Sponsor Checks & Scholarship Checks

Payments made by sponsors and/or scholarship agencies must be sent directly to Student Accounts

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.

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.

Card Office

Josh Frederick, Manager
Office: Warner Hall A15, 5000 Forbes Avenue Pittsburgh, PA
15213-3890
Phone: (412) 268-5224
Fax: (412) 268-5310
E-mail: idplus@andrew.cmu.edu

The Carnegie Mellon ID+ Card is the official ID card for students, faculty, and staff of Carnegie Mellon. The Card serves as official photo identification; provides after-hours access to academic buildings; access to athletic events and facilities; access to residence halls; permits free transportation on the Port Authority Transit (PAT) system; serves as your Carnegie Mellon library card; authorizes your campus printing; and so much more! You can use your ID+ Card for banking through PNC Bank (with a valid PNC Bank account and **after** linking your ID+ Card to your account). Your ID+ Card is a necessity of every day campus life. Remember to always carry your ID+ Card with you.

Plaid Ca\$h

Plaid Ca\$h is a debit account with the university. The account is accessible by presenting your Carnegie Mellon ID+ Card to the cashier at any of the locations where Plaid Ca\$h is accepted. For more information, visit The Card Office in Warner Hall, lower level, or The Card Office website at www.cmu.edu/idplus/.

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.
2. No examinations given outside of class time (excluding make ups and self-scheduled examinations) shall be administered on a Friday after 4:30 pm, or at any time Saturday or Sunday.
3. The instructor administering an exam (or another required class event) that falls outside class time must make any and all reasonable accommodations to provide an alternative time to students who have conflicts with the proposed time period, including those conflicts due to activities, meetings, other classes, etc. (provided that the instructor is notified of such conflict in a timely manner).
4. No student shall be required to take more than two full-period in-class or out-of-class examinations on the same day. It is the responsibility of the student to notify the instructor in a timely manner of his/her circumstance so that appropriate accommodations can be made.

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 associate dean of his or her home 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. Since 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.

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.

Contact

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

Carnegie Mellon Freedom of Expression Policy

Freedom of Expression Policy

Carnegie Mellon University values the freedoms of speech, thought, expression and assembly - in themselves and as part of our core educational and intellectual mission. If individuals are to cherish freedom, they must experience it. The very concept of freedom assumes that people usually choose wisely from a range of available ideas and that the range and implications of ideas cannot be fully understood unless we hold vital our rights to know, to express, and to choose. The university must be a place where all ideas may be expressed freely and where no alternative is withheld from consideration. The only limits on these freedoms are those dictated

by law and those necessary to protect the rights of other members of the University community and to ensure the normal functioning of the University.

Rights

On Carnegie Mellon's Campus, anyone may distribute printed material, offer petitions for signature, make speeches, and hold protests or demonstrations outside university buildings. All such activities must be peaceful, avoiding acts or credible threats of violence and preserving the normal operation of the university. No event shall infringe upon the rights or privileges of anyone not in sympathy with it, and no one will be permitted to harm others, damage or deface property, block access to university buildings or disrupt classes. The enforcement of these conditions will not depend in any way on the message or sponsorship of the act or event. When guests are invited by a recognized campus organization, they may express their ideas not because they have a right to do so, but because members of the campus community have a right to hear, see, and experience diverse intellectual and creative inquiry. Defending that right is a fundamental obligation of the university. Controversy cannot be permitted to abridge the freedoms of speech, thought, expression or assembly. They are not matters of convenience, but of necessity.

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 of the Code of Federal Regulations, Part 46 (45 CFR 46). Under federal 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) broad 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 for determining when additional expertise is required for adequate review and for 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.¹

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 copyrightable 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 directly reimburse 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.

3. Policy Provisions

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. If the university declares 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 the owner of intellectual property resulting from said work. In such cases the university must specify in advance the disposition of any intellectual property rights arising from the project. If the university declares itself to be a sponsor, but does not declare itself 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 internally sponsored work of the intellectual property ownership rights specified by the university as to that work 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 were employed specifically 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, the creator of any intellectual property may choose to place 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 agreement, university sponsorship arrangement or terms of employment as described in Provisions 3-1, 3-2 or 3-3. 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 release 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, ownership 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 paragraph share the attribute that they display information or visual or auditory appearances which are fully revealed to the purchaser or consumer. Thus, for example, source code listings would also be considered within this category. On the other hand, most computer software and data bases do not share this attribute; they are characterized by their capacity to perform tasks. 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 only 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, this license includes access by specified university personnel to the source listings, and the university shall require each person to whom a disclosure is made to execute in advance a binding confidentiality agreement in favor of and enforceable by the creator. If the intellectual property is created solely by a student or students, the creator is exempt from the obligation to pay 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.

3-6-3-2. 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 ownership rights to that property may be acquired by the university. Intellectual property acquired by the university in this fashion will be treated as in 3-6-4-1 below.

Procedural Provisions: At the time the intellectual property is disclosed to the university's provost as required under Section 4-1, or at any time thereafter, the university may request that the creator decide whether he will develop the intellectual property or will grant the rights to the university, and execute documents to pass on the title. Such a decision must be made within one year of the request or the creator will automatically lose his rights in favor of the university.

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 created with substantial use of university facilities provided by an external agreement or internal university sponsorship 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 research contract or a specific university sponsorship agreement, and when 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 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 unreimbursed substantial 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 make substantial unreimbursed use of university facilities except by explicit prior agreement. Any member of the university community who is engaged in consulting work or in 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:

- 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 and 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, and on graduate and undergraduate students when admitted. Current faculty and staff will also become bound by this policy when they sign new employment contracts as the result of the renewal of limited-term appointments or promotion. Other university personnel, including tenured faculty, and current staff and students may choose to become bound by this policy for future and pending intellectual property by voluntary written consent. Unless the creator and the university agree to a different arrangement, intellectual property that is already partially developed at the time this policy becomes effective will be treated according to the provisions of the patent policy by which the University creator is currently bound. Similarly, members of the university working under contracts signed before the effective date of this policy who do not choose to accept this policy will remain bound by the patent policies that already apply to them. With respect to intellectual property developed during the course of employment at the university, this policy shall continue to be binding on any person whose relationship with the university becomes terminated. The university should take all administrative steps necessary to ensure that employees and students sign, upon initial employment, registration or at other appropriate times, forms that indicate their acceptance of this policy.

7. Amendments of the Policy

Amendments of this policy may be proposed by the Faculty Senate, Staff Council or university administration. Proposed amendments must be approved by a two-thirds majority of votes in the Faculty Senate and subsequently approved by a simple majority of votes cast in a referendum administered by the Faculty Senate that is open to all members of the faculty as defined by this policy and to the exempt staff, provided that this majority constitutes at least 25% (twenty-five percent) of those eligible to vote. This referendum must be preceded by an opportunity for public discussion open to all interested faculty, administration, staff and students. Amendments that are supported by the faculty and staff must then be approved by the president of the university and adopted by the university trustees. Once adopted, amendments will become binding on new faculty, administration, and staff when hired, on existing faculty and staff when they sign new employment contracts, and on graduate and undergraduate students when admitted. Other university personnel, including tenured faculty, and current 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 biographic 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.
- The university will reply to you no later than 45 days after your request. If the university does not agree to amend the record, you have a right to a hearing on the issue.

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 proprietary 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 considerable 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 of 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 bboard official.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 with no intention of returning) or by taking a leave of absence (leaving the university temporarily, with the firm and stated intention of returning).

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 tuition being charged to the

midpoint of the semester or 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.

Students are required to fill out all information on the form, including all comment sections relating to reasons for their leave. After completing the form, students must take it to their home department and dean's office for appropriate signatures. The process of taking a leave will not be complete until all necessary signatures are on the leave form. Under certain circumstances, students may also need the Dean of Student Affairs to sign the appropriate form. Nonresident alien students must consult the Office of International Education for information on possible visa implications prior to going on leave.

Students on leave are not permitted to live in university housing or attend classes or maintain employment as students at Carnegie Mellon while their leave is in effect.

Doctoral candidates under ABD status (All But Dissertation) who wish to take a leave of absence should refer to the ABD and In Absentia policy.

Leaves during the academic semester will take effect as of the date signed by the student's dean. After the Leave of Absence or Withdrawal Form is received by Enrollment Services, it will be reviewed for appropriate tuition refunds (see Enrollment Services: Tuition and Fees Adjustment Policy) and grade implications. 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

www.cmu.edu/policies/documents/StLeave.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; or
- 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 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 PlaidCash 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.

Contact

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

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 a financial suspension, the student will be restricted from registering for and enrolling in university courses and programs, and s/he 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.

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

Procedures

Currently Enrolled Student/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 clearly address the outstanding balance and consequences of nonpayment. It will be mailed with the student's follow-up spring semester statement/s of student account. Any graduating student who does not clear his/her account balance prior to commencement will not receive a diploma. In addition, 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.

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, dining, 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 2 consecutive terms), 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 s/he 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 have eligibility 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 have eligibility 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.

Statement of Assurance

Carnegie Mellon University does not discriminate and Carnegie Mellon University is required not to discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex or handicap in violation of Title VI of the Civil Rights Act of 1964, Title IX of the Educational Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973 or other federal, state, or local laws or executive orders.

In addition, Carnegie Mellon University does not discriminate in admission, employment, or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or gender identity. Carnegie Mellon does not discriminate in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Presidential Executive Order directing the Department of Defense to follow a policy of "Don't ask, don't tell, don't pursue" excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-6684 or the Vice President for Campus Affairs, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-2056.

38 University Policies

Carnegie Mellon University publishes an annual campus security report describing the university's security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The [security report](#) is also available online.

Obtain general information about Carnegie Mellon University by calling 412-268-2000.

Undergraduate Academic Regulations

Availability of Required Courses

In order to insure 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 On-Line Registration (OLR) 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 Associate Dean 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 mid-point for that course.

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.

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 affords 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.

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 on-line academic audit website: <https://acis.as.cmu.edu/gale2/audit/degreeaudit.html>. 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.

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.

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."

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 also are offered at other times: students may elect to take such courses during the 4:30 to 6:30 p.m. period.

Diploma and Transcript Information

A Carnegie Mellon diploma is a student's certificate of accomplishment. The student's official transcript is to be considered the official record for all degree(s), major(s), minor(s), and honors.

Diplomas

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.

Transcripts

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.

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)

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 QPA.
- 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.

For additional information, visit The HUB website.

Grading Policies

Policy Statement

This policy offers details concerning university grading principles 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 Grading 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

Certain 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).

2. Policy Provisions

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 letter grade or an incomplete grade within one month of Enrollment Services query, the department head will be responsible for insuring that a grade is assigned.

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 circumstances and only with the approval of the instructor and, for undergraduates, 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 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 N 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 arranged and approved by the course instructor. A student wishing to audit a course is required to register for the course, complete the Course Audit Approval Form, obtain permission of the course instructor and their advisor, and return the form to The HUB 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 last class day, prior to the beginning of final examinations. After the deadline to drop, a W (withdrawal) grade is assigned and appears on the student's academic record. W grades do not apply to graduate students except in Tepper and MCS.

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 as registered for a minimum of 36 units. Permission to drop below the 36-unit minimum can only be granted in extraordinary circumstances by the student's home Associate Dean. Undergraduates who are registered as part-time are also subject to the above deadlines to drop or withdraw from a course.

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 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:

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

This grading standard is for all students classified as seeking an undergraduate degree and special students taking undergraduate courses.

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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:

Grade	Quality Points	Definition
A+	4.33	(Not applicable to CIT or H&SS)
A	4.0	
A-	3.67	
B+	3.33	
B	3.00	
B-	2.67	
C+	2.33	
C	2.00	
C-	1.67	
D+	1.33	(Not applicable to Tepper School, Heinz College, or H&SS)
D	1.00	(Not applicable to Tepper School, Heinz College, or H&SS)
R	0.0	Failure
X	0.0	Conditional Failure
S	Non-Factorable	Satisfactory
P	Non-Factorable	Passing
N	Non-Factorable	Not Passing
O	Non-Factorable	Audit
W	Non-Factorable	Withdrawl
I	Non-Factorable	Incomplete
AD	Non-Factorable	Credit granted for work completed at another institution or examination credit

Grading standards are based upon a student's home academic program and is 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:

Grade	Meaning	Quality Point Value
A	Excellent	4
B	Good	3
C	(satisfactory)	2
D	Passing	1
R	Failure	0

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:

11 units in Mathematics "A"		
11 units x 4 quality points	=	44 quality points
10 units in Physics "R"		
10 units x 0 quality points	=	0 quality points
9 units in Chemistry "B"		
9 units x 3 quality points	=	27 quality points
9 units in History "C"		
9 units x 2 quality points	=	18 quality points
9 units in English "D"		
9 units x 1 quality point	=	9 quality points
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.

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 the submission of official final transcripts to the Office of Enrollment Services.

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.

Procedure for the Appeal of Grades & Academic Actions

Students who believe that a grade which has been awarded to them is incorrect or that an academic action, recommended by their department and approved by the College Council, is unreasonable or inconsistent with the practice of the college should use the following procedures for prompt and equitable resolution of the grievance.

In the case of grades the student must:

1. Present the case verbally to the faculty or staff member responsible for the course in which the student believes an inappropriate grade has been awarded.
2. Present the grievance in written form with appropriate documentation to the department head of the department responsible for the course if Step 1 does not resolve the

grievance. The department head will provide within 30 days a written decision and the basis for it in the matter of the grievance.

3. Present copies of all documents originally sent to the department head in Step 2 and a formal letter of appeal to the College Council of the college responsible for the course if the student believes that Step 1 does not adequately resolve the grievance or if no decision has been rendered within the 30 days provided for in Step 2. The Dean of the college, acting for the university, will respond in writing with prompt and equitable resolution of the complaint, normally within 30 days and will document the basis for the College Council's decision.

In cases in which the student believes an academic action recommended by the head of the department and approved by the College Council is inconsistent with the policies of the college or incorrect, the student should use the following procedure:

1. In writing, the student must petition the College Council to make a formal review of the appropriateness of the action, such review to take place at the next scheduled meeting of the College Council.
2. The Dean of the college will provide in writing within 30 days after the next scheduled meeting of the College Council the response of the council to the petition and the basis for it.

If, after carrying out the steps described above as appropriate, the student believes that the matter is not adequately resolved or if no decision has been rendered on the last step outlined for the particular grievance, the student must present copies of all documents and a formal letter of appeal to the Provost or another university officer designated by the President for resolution of the grievance. That officer, acting for the university, will respond in writing with prompt and equitable resolution of the complaint, normally within 30 days, and will document the basis for the decision.

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 QPA is greater than 3.5) and/or recommendation of the faculty.

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 QPA through the preceding semester or at least a 3.00 (3.50 for students in ECE) semester QPA 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.

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.

Residency Requirement

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. Note that these are minimum residency requirements applicable to all

university undergraduates. 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 Residency 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.

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.

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

(Now referred to variously as track, option, etc.)

A specific area of study associated with the major or additional major(s), which transforms the title of the major or additional major. Examples: Civil Engineering (Biomedical Engineering Option) Physics (Computer Science Option)

Concentration

(Now referred to variously as track, option, etc.)

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 of 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.

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

Certification: department

Concurrent college (if any), concurrent department (if any)

Second concurrent college (if any), second concurrent department (if any)

Minor

One degree, stating the major first and the minor second (or third, if there is also (an) additional major(s) involved). The type of degree sought (B.A., B.S.) is determined by the major (that of the home department). Minors are not listed on the diploma, but appear on the transcript.

Examples: B.F.A. in Music Performance (Voice) with a minor in Theatre Arts; B.S. in Applied History with an additional major in Information Systems and a minor in Mathematics.

Requirements: The student would generally take 45 units pertaining to the minor, in addition to fulfilling all requirements for the major degree (as defined by the home college). The "minor" courses are negotiated between the student and the department certifying the minor.

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

Certification: department

Options (Tracks, Specializations, Area Cores, etc.)

These concentrations will not be considered part of the student's degree title unless included are part of the major or (an) additional major(s) field title.

Additional Majors/Minors Declaration Process

For undergraduates, all variations on a student's sought degree and major field must be declared by the end of the first semester of the student's junior year. Having already declared a major, students should be well prepared by this time to choose additional majors and/or minors.

It is assumed that by these proposed deadlines, the student will have taken a majority of degree requirements and electives. The student can then, in conjunction with an advisor, review his/her course history and decide which options may or may not apply towards the desired degree and field(s).

A student who wishes to pursue additional majors and/or minors should consult with his/her advisor and receive a detailed curriculum for attaining the additional desired degree, major or minor. The student should then notify the college/department offering the additional program. Upon receipt of this notification, the college/department will update the Student Information System which will reflect this information to the Commencement System for

graduation. This procedure ensures that when a student is expected to graduate, all degree/major information is immediately accessible, and certification of the degree is simplified.

Multiple Degrees Involving Graduate Degrees

Policies involving multiple graduate degrees or a graduate/undergraduate degree program or sequence are dictated by each college involved.

Examples: M.S. in Public Management and Policy and the degree of Juris Doctor (Heinz College/University of Pittsburgh School of Law).

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

Declaration: Graduates: upon admittance OR by the end of the semester preceding the expected graduation date.

Certification: Home college, home department and concurrent college (if any), concurrent department (if any).

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.

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.

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.

Student Suspension/Required Withdrawal Policy

Policy Statement

University Suspension is a forced, temporary leave from the university. There are three types of suspension for students that apply to both graduate and undergraduate students:

Academic Suspension is the result of poor academic performance or violation of academic regulations and is imposed by the student's college or academic department (see university and college academic policies).

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.

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 PBT or 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 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 chose 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.

University Services

Assistance for Individuals with Disabilities

Equal Opportunity Services
Whitfield Hall, 143 N. Craig Street, Pittsburgh PA 15213
<http://hr.web.cmu.edu/eos.html>
Everett Tademey, 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-lpowell@andrew.cmu.edu or visit our website at <http://hr.web.cmu.edu/eos.html>

Carnegie Mellon Resource Advising Center (CMARC)

Ty Walton, Director
Damian Dourado, Asst. Director
CMARC Office: Cyert Hall A64, 8-2150

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, x8-2649
<http://www.cmu.edu/computing/>

The Computing Services division develops, maintains and supports the computing, instructional technology and telecommunications resources for the students, faculty and staff of Carnegie Mellon. The division maintains the campus wired and wireless network and public computer clusters. They are also responsible for system software development and cable TV and telephone services such as voicemail and long distance. Computing Services also installs and maintains the audio/video equipment in most of the academic classrooms. Visit <http://www.cmu.edu/computing/> for additional information.

Policies and Guidelines

The Carnegie Mellon Computing Policy establishes general rules for the use of computing, telephone and information resources. The policy is supported by a number of guidelines. All campus affiliates own the responsibility to read and be familiar with the policy and guideline statements available at <http://www.cmu.edu/computing/guideline/>.

The Portal Software and Account Services

Use the Carnegie Mellon web portal at <http://my.cmu.edu/> for easy access to a variety of information and services on the web. Through the Portal "My Accounts" tab, you can change your Andrew password, set mail forwarding and download software.

Student Advisory Committee

<http://www.cmu.edu/computing/partners/sac/>

The Student Advisory Council (SAC) meets once a month during the academic year to articulate the student body's computing needs and perspectives to members of Computing Services. Students who are interested in becoming SAC members can do so through the SAC web site.

The Help Center

Cyert Hall 119, x8-HELP
<http://www.cmu.edu/computing/repair/help-center.html>

The Help Center technical staff answers questions related to computing at Carnegie Mellon. Consultants are available on weekdays by telephone between 7 a.m. - 7 p.m. and in person between 9:00 a.m. to 5:00 p.m. For non-urgent matters, contact the Help Center via email to advisor@andrew.cmu.edu. The Help Center also handles computer account issues; a complete account directory is available at <http://www.cmu.edu/directory/>.

Information Security Office

Cyert Hall, x8-8556
<http://www.cmu.edu/iso/>

The Computing Services Information Security Office (ISO) ensures the safety and security of the campus computing environment. The office maintains a web presence that offers links to security downloads and patches to secure your computer.

Computing Clusters

x8-8776
<http://www.cmu.edu/computing/clusters/>

Cluster Services provides 400 UNIX, Macintosh, and IBM-compatible computers in seven public computer labs known as "clusters". Most clusters are open 24 hours per day when classes are in session and have a consultant on duty to answer basic computing questions. In conjunction with the College of Fine Arts, Cluster Services also operates the Multimedia Studio located in the College of Fine Arts building. The Multimedia Studio provides students with the multimedia digital equipment for digital video, animation, and computer modeling, digital imaging, digital sound recording, music composition, and large format color printing. This facility is available to the campus community with preference for CFA courses and coursework.

Telecommunications

Bramer House, x8-8500
<http://www.cmu.edu/computing/network/phone/>

Telecommunications provides telephone services to students, faculty, and staff including lines, equipment, maintenance, voicemail and long distance. Telecommunications also manages the university's Cable TV services.

For More Information

A comprehensive collection of computing documentation is available on line at <http://www.cmu.edu/computing/documentation/>. Printed copies of some of these documents are also available at the Help Center in Cyert Hall 119. For information that is geared to new students, faculty or staff members, visit the new user web site at <http://www.cmu.edu/computing/new-user/>.

Division of Student Affairs

G. Richard Tucker, Interim 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

Warner Hall 301, 412-268-2075,
<http://www.studentaffairs.cmu.edu/dean.cfm>
G. Richard Tucker, Interim Dean of Student Affairs, Paul Mellon
University Professor of Applied Linguistics

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 CenterCenter

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 CenterCenter 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

Morewood Gardens E-Tower, 412-268-2922,
<http://www.studentaffairs.cmu.edu/counseling>
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

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

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

Warner Hall 301, 412-268-5231
<http://www.cmu.edu/oie>
 Linda Gentile, Director

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 professors 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 students 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

Morewood Gardens, 412-268-4887
<http://www.studentaffairs.cmu.edu/first-year>
 Anne R. Witchner, Assistant Dean of Student Affairs

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

University Center 103, 412-268-8704
<http://www.studentaffairs.cmu.edu/StudentActivities/>
 Elizabeth Vaughan, Interim Director

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, our 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 Development Office

Morewood Gardens, 412-268-9510
<http://www.studentaffairs.cmu.edu/student-development>
 John Hannon, Director

The Student Development Office coordinates services, programs and experiences designed to encourage discovery, reflection and self-awareness through the first year residential house experience. A significant portion of this experience focuses on leadership development, social engagement, and community service. To that end, the structure of the house model is designed to promote significant interaction between community members. Students are encouraged to take an active role within their house communities. From improvements to the physical space to a breadth of leadership opportunities, students are strong partners in building safe, positive communities in which each person may share with others their unique strengths and talents. Students drive much of the programming within and between house communities, and student support is critical for community success. Housefellows and student office staff design and implement the residential house experience in Donner, Hamerschlag, Morewood E-Tower, Mudge, Scobell and Stever House. Our commitment to student leadership and personal development in these house settings is also expressed through the advising and support provided to the Student Dormitory Council (SDC) as well as the faculty partnerships that are cultivated through the Big Questions initiative.

Student Life Office

Morewood Gardens, 412-268-2142
<http://www.studentaffairs.cmu.edu/student-life>
 Holly Hippensteel, Director

The Student Life Office provides opportunities that emphasize community engagement and social responsibility while actively supporting the personal and professional development of students. To this end, we:

- Coordinate educational initiatives and accountability related to academic and non-academic Community Standards;
- Advise student initiatives including Sexual Assault Advisors, Safewalk, and the Strong Women Strong Girls mentoring program;
- Facilitate programs related to gender and gay/lesbian/bisexual identity including the MOSAIC conference and Pride Month; and
- Advise and support the twenty-four social, Greek-letter organizations and associated governing bodies that comprise the fraternity and sorority community.

Our staff members also serve as housefellows to Doherty House, Woodlawn Apartments, Roselawn Apartments, Margaret Morrison Apartments, Spirit House, Cathedral Mansions, Fairfax Apartments, Shady Oak Apartments, and Veronica as well as the fraternities and sororities.

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, apartment, or house. 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 develop 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 WebISO 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 returning 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 join a wait list for spaces remaining after all returning residents, incoming first-year students and transfer students have been housed.

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, utility companies, etc. is included on the site.

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", "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 when, where and what you want to 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.

Students 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. Flexible 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 Eat 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 choose entrees, "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 Plaid 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 Plaid 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.

Fast Facts

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 Fast Facts

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 to 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>
eslhelp@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.

Fellowships

Fellowships and Scholarships Office (FSO)

Stephanie Wallach, Director
Judy Zang, Fellowships Advisor
Julia Spencer, Program Assistant
<http://www.cmu.edu/fso>

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 to 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 nonetheless 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 works 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

Carnegie Mellon shelters a chapter of the Phi Beta Kappa Society, sponsored by the three colleges (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 *Philosophia Biou Kybernetes*, 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, *Philosophia Kratoito Photon*, "Let the love of wisdom rule humanity." 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, Director
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 conducting research with a faculty advisor 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.

Advising and Information Services

The Director of the Undergraduate Research Office is available to discuss project ideas, locate possible funding sources, and generally facilitate the research process. The Office also maintains a website containing announcements of research opportunities, summer programs, fellowships, seminars and conferences.

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. Deadlines are October for the Spring grant period and in March for the Summer and Fall grant periods.

Summer Undergraduate Research Fellowship (SURF)

Also known as SURF, these fellowships are designed to allow students a 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 SURF 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.

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.

Intel First Year Research Experience (IFYRE)

First- and 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.

THOUGHT

THOUGHT is Carnegie Mellon's undergraduate research journal—a student-run journal where students can publish the results of their research findings. Our undergraduate design and professional writing majors can join computer scientists, engineers, and history, business, and biology majors—just to name a few—to make this an exciting and growing part of our URO programs.

Undergraduate Research Office
www.cmu.edu/uro
sw4s@andrew.cmu.edu
412.268.5702

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.

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)
- Evgefstos
- Kosher Korner
- 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.

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: Lieutenant John Race, acting 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 in 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 "Campus Security Reports."

University Libraries

Dean: Gloriana St. Clair
Office: Hunt Library / 412-268-2447 / gstclair@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.

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

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.

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:

03-121	Modern Biology	9
03-230	Intro to Mammalian Physiology or 42-202 Physiology (9 units)	9
03-124	Modern Biology Laboratory or 03-343 Experimental Techniques in Molecular Biology (12 units) or 03-206 Biomedical Engineering Laboratory (9 units)	9

2. One year of general chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
09-221	Laboratory I: Introduction to Chemical Analysis	12

3. One year of organic chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

09-217	Organic Chemistry I	9
09-218	Organic Chemistry II	9
09-222	Laboratory II: Organic Synthesis and Analysis	12

4. One year of physics with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

33-106 /111	Physics I for Engineering Students (for science or engineering students)	12
33-112	Physics II for Science Students	12
33-100	Basic Experimental Physics	6

5. One year of English.

This is typically fulfilled by the following Carnegie Mellon courses:

76-101	Interpretation and Argument	9
76-xxx	English course of the student's choice, typically 200-level or higher	

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 page 287 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 preceptor-ship/ 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)

Carnegie Institute of Technology:

- Biomedical Engineering
- Engineering Studies
- Robotics Technology and Policy

Designated Minors (open only to CIT students):

- Automation and Control
- Biomedical Engineering
- Colloids, Polymers and Surfaces Technology
- Data Storage Systems Technology
- Electronic Materials
- Engineering Design
- Environmental Engineering
- Manufacturing Engineering
- Materials Science and Engineering
- Mechanical Behavior of Materials
- Robotics

The College of Fine Arts:

- Accompanying (open only to students majoring in Music)
- Architecture
- Architectural History (available also to B.Arch. candidates)
- Architectural Representation and Visualization
- Architectural Technology
- Art
- Building Science (open only to B. Arch. candidates)
- Communication Design
- Conducting (open only to students majoring in Music)
- Drama
- History of the Arts
- Industrial Design
- Jazz Performance
- Jazz Performance (for students majoring in Music)
- Music
- Music Education (for students majoring in Music)
- Music Performance
- Music Technology
- Music Theory
- Photography, Film and Digital Imaging

The College of Humanities and Social Sciences:

- African and African American Studies
- Chinese
- Decision Science
- English
- Environmental Policy
- Ethics
- European Studies
- Film and Media Studies
- French and Francophone Studies
- Gender Studies
- German
- Hispanic Studies
- History
- International Relations
- Japanese
- Linguistics
- Logic and Computation
- Minority Studies
- Multimedia Production
- Philosophy
- Policy and Management
- Political Science
- Psychology
- Religious Studies
- Russian Studies
- Science, Technology and Society
- Second Language Acquisition
- Sociology
- Statistics
- Student Defined

Tepper School of Business:

- Business Administration Management (for Students in CFA)

Mellon College of Science:

- Biological Sciences
- Chemistry
- Discrete Mathematics and Logic
- Environmental Science
- Mathematical Science
- Physics
- Scientific Computing
- Secondary Education and Teacher Certification

School of Computer Science:

- Computer Science

Pre-Law Advising Program

Director: Joseph Devine, Associate Dean for Undergraduate Studies, H&SS

Office: H&SS 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 weekly pre-law newsletter, pre-law library, 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 with the student Pre-law Society and Undergraduate Student Mock Trial Association.

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 page 60

Reserve Officers' Training Corps (ROTC)

Please see page 62

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 defacto "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 de facto "home college" 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 faculty advisor, colleges, and the 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:

Department of Athletics
Skibo Gymnasium
Carnegie Mellon University
Pittsburgh, PA 15213
(412) 268-8551

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, Espresso Bike EFX, steppers, Cybex machines, dumbbells, a sauna and a whirlpool. Gesling 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.

TONY WINGEN, Head Men's Basketball Coach/Associate Athletic Director/Instructor – M.Ed., Springfield College; Carnegie Mellon, 1990–.

Faculty

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–.

TERRY BODNAR, Assistant Football Coach/Instructor – M.S., Indiana University of PA, Carnegie Mellon, 1984–.

SUZANNE BOWSER, Assistant Women's Basketball Coach/Instructor – M.S., Southern Utah University, Carnegie Mellon, 2008–.

JOSH CENTOR, Assistant Director of Athletics – B.A., Brandeis University, Carnegie Mellon, 2008–.

DARIO DONATELLI, Head Men's Cross-Country & Track Coach – M.S., Indiana University of PA, Carnegie Mellon, 1984–.

RICHARD ERDELYI, Assistant Football Coach and Head Golf Coach/Instructor – B.A., University of Pittsburgh, Carnegie Mellon, 1987–.

SARA GAUNTNER, Assistant Director of Athletics for Instructional Programs & Recreation & Aquatics Director/Instructor – M.S., Gannon University & Duquesne University, Carnegie Mellon, 2005–.

ANDREW GIRARD, Head Men's and Women's Tennis Coach/Instructor – B.S., Michigan Tech University, Carnegie Mellon, 2003–.

TODD JACKSON, Assistant Director of Athletics for Intramurals & Club Sports & Intramurals Director/Instructor – M.S., University of Connecticut; Carnegie Mellon, 2009–.

JUSTIN JENNINGS, Assistant Men's Basketball Coach/Instructor – MBA, Penn State Behrend, Penn State Behrend; Carnegie Mellon, 2008–.

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–.

BRENT KINTZER, Assistant Men's & Women's Swimming Coach/Instructor – M.S., Virginia Commonwealth University; Carnegie Mellon, 2008–.

RICHARD LACKNER, Head Football Coach/Instructor – B.A., Carnegie Mellon, Carnegie Mellon, 1979–.

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–.

JENNIFER MYHRE, Assistant Women's Soccer Coach/Instructor – M.S., University of Washington; Carnegie Mellon, 2009–.

MICHAEL PIRANIAN, Assistant Men's Soccer Coach/Instructor – B.S., Virginia Polytechnic Institute & State University, Carnegie Mellon, 2008–.

KEVIN SCHULTZ, Strength & Conditioning Coach & Assistant Football Coach/Instructor – B.A., University of Wisconsin-La Crosse; Carnegie Mellon, 2008–.

GERRI SEIDL, Head Women's Basketball Coach/Instructor – B.S., University of Pittsburgh; Carnegie Mellon, 1984–.

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–.

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 and a half year scholarships are available on a competitive basis to qualified students. Many AFROTC scholarships cover a portion of tuition costs, incidentals 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 supporting 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 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 JROTC 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

Freshman Year		Units
30-101	Introduction to Military Leadership - Fall	5
30-102	Foundations of Leadership - Spring	5

Sophomore Year		Units
30-201	Leadership Dynamics and Application - Fall	5
30-202	Applications in Leadership and Combat Power - Spring	5

Junior Year		Units
30-301	Basic Leader Planning and Combat Operations - Fall	5
30-302	Advanced Leader Planning and Combat Operations - Spring	5
Leadership Development & Assessment Course (six-week required summer camp)		

Senior Year		Units
30-401	Progressive Leadership Theory and Applications - Fall	5
30-402	Transition to the Profession of Arms - Spring	5

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 Advanced Course if the Basic Course cannot be fulfilled. It is taken the summer before the sophomore and junior 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.

NROTC midshipmen lead the same campus life as other Carnegie Mellon students. They make their own arrangements for room and board, choose a preferred area of study and participate in extracurricular activities. 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 the 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 applied for a NROTC scholarship 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 and incur a four-year active duty obligation in a selected area of the naval service.

College (Non-Scholarship) Programs in NROTC

Qualified students may participate in NROTC as college program (non-scholarship) midshipmen and earn commissions 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.

64 Reserve Officers' Training Corps (ROTC)

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.

Naval Professional Academic Courses (Naval Science Courses)

Freshman Year		Units
32-100	Naval Laboratory	3
32-101	Introduction to Naval Science	6
32-102	Seapower and Maritime Affairs	6

Sophomore Year		Units
32-200	Naval Laboratory	3
32-201	Leadership & Management	9
32-212	Navigation *	9

Junior Year		Units
32-300	Naval Laboratory	3
32-310	Evolution Of Warfare **	9
32-311	Naval Ship Systems I-Engineering *	9
32-312	Naval Ship Systems II-Weapons *	9

32-400	Naval Laboratory	3
32-402	Leadership and Ethics	6
32-410	Amphibious Warfare **	9
32-411	Naval Operations and Seamanship *	9

Footnotes:

* Required of students in the Navy Option

** Required of students in the Marine Option

All other 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–.

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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 page 76.

Bachelor of Science in Computational Finance

The Mellon College of Science, the Heinz College 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 four depth electives. Tepper students must take three 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 follow the science curriculum outlined below. Specifically, students 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.

In addition, in the freshman year students should complete two of the following three courses:

33-111	Physics I for Science Students	12
03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry I	10

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
73-150	Intermediate Microeconomics	9
73-200	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 I	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 curriculum below includes four depth electives.

These are to 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
36-461	Topics in Statistics	9
70-391	Finance	9
70-398	International Finance	9
70-492	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 degree Bachelor of Science in Computational Finance in the Mellon College of Science. The courses listed are required. The semesters in which the courses are to be taken are suggested.

Freshman Year

Fall		Units
15-110	Principles of Computing	10
21-120	Differential and Integral Calculus	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Science Requirement	9-12
		<hr/> 41-44

Spring		Units
94-701	Strategic Writing Skills	6
xx-xxx	Depth Elective	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	0-6
		<hr/> 42-48

Spring		Units
15-121	Introduction to Data Structures	10
21-122	Integration, Differential Equations and Approximation	10
70-122	Introduction to Accounting	9
xx-xxx	Science Requirement (9-12 units)	12
xx-xxx	Elective	9
		<hr/> 50

Tepper Detailed Curriculum

What follows is the detailed curriculum for the degree 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

Sophomore Year

Fall		Units
21-241	Matrix Algebra	9
	or 21-341 Linear Algebra (9 units)	
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
73-100	Principles of Economics	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
		<hr/> 45

Fall		Units
15-110	Principles of Computing	10
21-120	Differential and Integral Calculus	10
	or 21-122 Integration, Differential Equations and Approximation (10 units)	
70-100	Global Business	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		<hr/> 50

Spring		Units
21-270	Introduction to Mathematical Finance	9
21-292	Operations Research I	9
21-369	Numerical Methods	9
73-150	Intermediate Microeconomics	9
xx-xxx	Elective	9
		<hr/> 45

Spring		Units
15-121	Introduction to Data Structures	10
21-122	Integration, Differential Equations and Approximation	10
21-241	Matrix Algebra	9
73-150	Intermediate Microeconomics	9
xx-xxx	Breadth Course	9
xx-xxx	Breadth Course	9
		<hr/> 56

Junior Year

Fall		Units
21-325	Probability	9
21-370	Discrete Time Finance	9
73-200	Intermediate Macroeconomics	9
xx-xxx	Depth Elective	9
xx-xxx	Elective	9
		<hr/> 45

Sophomore Year

Fall		Units
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-325	Probability	9
70-122	Introduction to Accounting	9
73-200	Intermediate Macroeconomics	9
		<hr/> 45

Spring		Units
21-420	Continuous-Time Finance	9
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Modeling	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
xx-xxx	Depth Elective	9
		<hr/> 45

Spring		Units
21-270	Introduction to Mathematical Finance	9
21-292	Operations Research I	9
36-226	Introduction to Probability and Statistics II	9
70-311	Organizational Behavior	9
70-381	Marketing I	9
		<hr/> 45

Senior Year

Fall		Units
45-816	Studies in Financial Engineering	6
90-718	Strategic Presentation Skills	6
94-700	Organizational Design & Implementation	6
xx-xxx	Depth Elective	9
xx-xxx	Humanities, Social Science or Fine Arts	9
xx-xxx	Elective	9
		<hr/> 45

Junior Year

Fall		Units
21-370	Discrete Time Finance	9
70-391	Finance	9
xx-xxx	Depth Elective	9
xx-xxx	Breadth Course	9
xx-xxx	Elective	9
		<hr/> 45

	Units
Spring	
21-420 Continuous-Time Finance	9
21-369 Numerical Methods	9
36-410 Introduction to Probability Modeling	9
70-371 Production/Operations Management	9
xx-xxx Breadth Course	9
	45

Senior Year

	Units
Fall	
45-816 Studies in Financial Engineering	6
70-332 Business, Society and Ethics	9
70-401 Management Game	12
xx-xxx Breadth Course	9
xx-xxx Depth Elective	9
	45

	Units
Spring	
90-718 Strategic Presentation Skills	6
94-701 Strategic Writing Skills	6
xx-xxx Depth Elective	9
xx-xxx Breadth Course	9
xx-xxx Breadth Course	9
xx-xxx Elective	9
	48

The Computational Finance Minor

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.

or

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 Dean of the Mellon College of Science.

21-241 Matrix Algebra	9
or 21-341 Linear Algebra (9 units)	
21-259 Calculus in Three Dimensions	9
or 21-256 Multivariate Analysis and Approximation (9 units)	
21-260 Differential Equations	9
21-270 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.

*Pre-requisite for 21-370, 21-270 and either 21-256 or 21-259, and the co-requisite is 70-207, 21-325, 36-225 or 36-217.

** Pre-requisite for 21-420 is 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, 73-150, or 73-200.

Science and Humanities Scholars Program

Sponsored by the College of Humanities and Social Sciences and the Mellon College of Science
 Dr. William Alba, Director
 Office: Doherty Hall, Room 2201
 www.cmu.edu/shs

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 (29 units)		
21-120 Differential and Integral Calculus		10
or 21-131 Analysis I (10 units)		
21-122 Integration, Differential Equations and Approximation		10
21-132 Analysis II		10
(or appropriate substitute)		

Writing/Expression (9 units)

Language is a tool used to communicate, as well as a way to organize thinking. This university-wide requirement, to be completed in the first year, focuses on the social nature of language and the ways in which writing constitutes thinking.

76-101 Interpretation and Argument	9
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World Cultures (9 units)

This requirement seeks to enable students to recognize how cultures have shaped and continue to shape the human experience, as well as analyze material that provide clues as to how these cultures operate.

79-104 Global Histories	9
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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.

Computational Reasoning (9-10 units) Choose from the following courses:

15-110	Principles of Computing	10
15-121	Introduction to Data Structures	10
21-127	Concepts of Mathematics	9
80-210	Logic and Proofs	9
80-211	Logic and Mathematical Inquiry	9
80-212	Arguments and Logical Analysis	9

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.

03-121	Modern Biology	9
03-230	Intro to Mammalian Physiology	9
09-105	Introduction to Modern Chemistry I	10

or

09-106	Modern Chemistry II	10
09-107	Honors Chemistry: Fundamentals Concepts and Applications	10
33-111	Physics I for Science Students	12

or

33-112	Physics II for Science Students	12
33-131	Matter and Interaction I	12

or

33-132	Matter and Interactions II	12
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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.

80-130	Introduction to Ethics	9
80-150	Nature of Reason	9
80-180	The Nature of Language	9
80-221	Philosophy of Social Science	9
80-230	Ethical Theory	9
80-241	Ethical Judgments in Professional Life	9
80-242	Conflict and Dispute Resolution	9
80-270	Philosophy of Mind	9
85-100	Introduction to Intelligence in Humans, Animals and Machines	9
85-102	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

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	9
70-332	Business, Society and Ethics	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
79-319	Protest and Dissent in American History	9
79-266	Russian History: From Communism to Capitalism	9
79-331	Body Politics: Women and Health in America	9
79-335	Drug Use and Drug Policy	9
79-340	Who Shall Play? Gender and Race in American Sport	9
79-345	The Roots of Rock and Roll, 1870-1970	9
79-350	Early Christianity	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
80-341	Computers, Society and Ethics	9
88-104	Decision Processes in American Political Institutions	9
88-184	Topics of Law: The Bill of Rights	9
88-205	Comparative Politics	9

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	9
76-262	Survey of Forms: Nonfiction	12
76-265	Survey of Forms: Poetry	9
76-269	Survey of Forms: Screenwriting	9
80-220	Philosophy of Science	9
82-1xx	Any Elementary Modern Language course	
82-2xx	Any Intermediate Modern Language course	
99-241	Revolutions of Circularity	9

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	9
70-342	Managing Across Cultures	9
76-227	Comedy	9
76-232	African American Literature	9
76-241	Introduction to Gender Studies	9
79-113	Culture and Identity in American Society	9
79-311	Introduction to Anthropology	9
79-240	The Development of American Culture	9
79-207	Development of European Culture	9
79-345	The Roots of Rock and Roll, 1870-1970	9
79-241	African American History I	9
79-242	African American History II	9
79-224	Mayan America	9
79-261	Chinese Culture and Society	9
79-368	Poverty, Charity, and Welfare	9
79-330	Medicine and Society	9
80-100	Introduction to Philosophy	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
80-261	Empiricism and Rationalism	9
82-273	Introduction to Japanese Language and Culture	9
82-294	Topics in Russian Language and Culture	Var.
82-303	French Culture	9
82-304	The Francophone World	9
82-333	Introduction to Chinese Language and Culture	Var.
82-342	Spain: Language and Culture	9
82-343	Latin America: Language and Culture	9
82-344	U.S. Latinos: Language and Culture	9

70 Intercollege Programs

82-345	Introduction to Hispanic Literary and Cultural Studies	9
82-396	The Faust Legend at Home and Abroad	Var.
82-415	Topics in French and Francophone Studies	9
82-426	Topics in German Literature and Culture	9
82-451	Studies in Latin American Literature and Culture	9
82-491	Literature, Politics and Film in Russia & East Europe Today	Var.

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.

The Major in Mathematical and Statistical Sciences (B.S.)

This degree program is administered under the joint Science & Humanities Scholars Program between the Mellon College of Science and the College of Humanities & Social Sciences. To qualify, a student must be acceptable for admission to both colleges.

Mathematical Sciences: 85 Units

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergrad Colloquium	1
21-292	Operations Research I	9
21-355	Principles of Real Analysis I	9
or		
21-369	Numerical Methods	9
21-xxx	Mathematical Science Elective	
21-xxx	Mathematical Science Elective	

Probability and Statistics: 36 Units

21-325	Probability	9
or 36-225 Introduction to Probability Theory (9 units)		
Note: 21-325 Probability is preferred.		

36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Modeling	9
36-461	Topics in Statistics	9

Data Analysis: 27 Units

36-247	Statistics for Lab Sciences	9
36-309	Experimental Design for Behavioral and Social Sciences	9
or		
36-303	Sampling, Survey and Society	9
36-401	Modern Regression	9

Statistics and Data Analysis Electives: 18 Units

Complete two courses from the following:		
21-393	Operations Research II	9
36-402	Advanced Data Analysis	9
36-462	Topics in Statistics	9

In consultation with his/her advisor, the student may also arrange to take Statistics graduate courses (36-7xx) to satisfy part of this requirement.

Joint MCS/H&SS Core other than Mathematical Science

or Statistics courses: 103-107 Units

Free Electives:
Enough to reach 360 Units

Sample Course Sequence: Math & Statistical Sciences Freshman Year

Fall		
21-120	Differential and Integral Calculus	10
21-127	Concepts of Mathematics	9
76-101	Interpretation and Argument	9
33-111	Physics I for Science Students	12
99-10x	Computing @ Carnegie Mellon	

Spring		
21-122	Integration, Differential Equations and Approximation	10
36-247	Statistics for Lab Sciences	9
79-104	Global Histories	9
xx-xxx	Science	
xx-xxx	Freshman Seminar	

Sophomore Year

Fall		
21-201	Undergrad Colloquium	1
21-241	Matrix Algebra	9
36-309	Experimental Design for Behavioral and Social Sciences	9
xx-xxx	Economic, Political and Social Institutions	
xx-xxx	Science	
xx-xxx	Elective	

Spring		
21-201	Undergrad Colloquium	1
21-259	Calculus in Three Dimensions	9
21-292	Operations Research I	9
xx-xxx	Cultural Analysis	
xx-xxx	Electives	

Junior Year

Fall		
21-355	Principles of Real Analysis I	9
21-325	Probability	9
xx-xxx	Cognition, Choice and Behavior	
xx-xxx	Electives	

Spring		
21-xxx	Mathematical Science Elective	
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Modeling	9
xx-xxx	Creative Production & Reflection	
xx-xxx	Electives	

Senior Year

Fall			
21-393	Operations Research II	9	
36-401	Modern Regression	9	
36-461	Topics in Statistics	9	
xx-xxx	Electives		

Spring			
21-xxx	Mathematical Science Elective		
36-402	Advanced Data Analysis	9	
36-xxx	Senior Research Elective		
xx-xxx	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

Seminar

57-57x	Music and Technology Course (8 semesters)	12	
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University

99-10x	Computing @ Carnegie Mellon	3	
76-101	Interpretation and Argument	9	
79-104	Global Histories	9	

Humanities

xx-xxx	Cognition, Choice and Behavior course	9	
xx-xxx	English, History, Modern Languages, Philosophy, or Psychology course	9	

Mathematics

21-120	Differential and Integral Calculus	10	
21-122	Integration, Differential Equations and Approximation	10	
or			
21-115	Differential Calculus (AP)	5	
21-121	Integration and Differential Equations	10	
21-123	Calculus of Approximation	5	

Science

33-114	Physics of Musical Sound	9	
33-106	Physics I for Engineering Students	12	

Electives 29 Units

Music Core 104 Units

57-100	Convocation (8 semesters)	0	
57-152	Harmony I	9	
57-153	Harmony II	9	
57-408	Form and Analysis	6	
57-151	Concept and Practice of Counterpoint	6	
57-258	20th-21st Century Techniques	6	
57-257	Orchestration I	6	
57-271	Orchestration II	6	
57-189	Repertoire and Listening for Musicians I	3	
57-190	Repertoire and Listening for Musicians II	3	
57-289	Repertoire and Listening for Musicians III	3	
57-290	Repertoire and Listening for Musicians IV	3	
57-181	Solfege I	3	
57-182	Solfege II	3	
57-183	Solfege III	3	
57-184	Solfege IV	3	
57-161	Eurhythmics I	3	
57-162	Eurhythmics II	3	
57-283	Music History I	9	
57-284	Music History II	9	

Music and Technology Core 121 Units

15-110	Principles of Computing	10	
or15-121	Introduction to Data Structures (10 units)		
15-123	Effective Programming in C and UNIX	9	
15-322	Introduction to Computer Music	9	
18-100	Introduction to Electrical and Computer Engineering	12	
18-202	Mathematical Foundations of Electrical Engineering	12	
18-290	Signals and Systems	12	
57-101	Introduction to Music Technology	6	
57-347	Electronic and Computer Music	6	
57-337	Sound Recording	6	
57-338	Sound Editing and Mastering	6	
57-438	Multitrack Recording	9	
57-57x	Music and Technology Course	12	
57-57x	Music and Technology Course	12	

Students complete either the Music Concentration or the Technical Concentration:

Music Concentration 60 Units

57-5xx	Studio (4 semesters)	36	
57-4xx	Major Ensemble (4 semesters)	24	

Technical Concentration 57 or 55 Units

21-127	Concepts of Mathematics	9	
15-213 /18-243	Introduction to Computer Systems	12	

and either

18-220	Electronic Devices and Analog Circuits	12	
18-240	Structure and Design of Digital Systems	12	
15-2xx /18-3xx	Electives in ECE or CS or above	12	

72 Intercollege Programs

or

15-128	Freshman Immigration Course	1
15-211	Fundamental Data Structures and Algorithms	12
15-323	Computer Music Systems and Information Processing	9
15-2xx	/18-3xx Electives in ECE or CS	12
or above		

Total number of units required for major	394
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Major in Psychology & 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 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 Joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Specific 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 HSS or SHS. All other general education categories can be filled in any way that satisfies the requirements of the student's college of the SHS programs.

Mathematical Sciences/Statistics

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
36-247	Statistics for Lab Sciences *	9
36-309	Experimental Design for Behavioral and Social Sciences	9
* 36-201 can be used as an alternative, but 36-247 Statistics for Lab Sciences is strongly encouraged.		

Natural Sciences

09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
33-xxx	Physics I for Science Students	9
09-217	Organic Chemistry I	9
09-218	Organic Chemistry II	9

Computational Reasoning

99-10x	Computing @ Carnegie Mellon	15-100	Introductory/Intermediate Programming
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Discipline Core Requirements

Biological Sciences			
03-121	Modern Biology	9	
03-231	Biochemistry I	9	
03-240	Cell Biology	9	

Psychology			
85-102	Introduction to Psychology	9	

Complete three of the following courses (85-219 should be included as one of the three):			
85-211	Cognitive Psychology	9	
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	

NOTE: Students can also take four Survey courses, one of which should be 85-219 Biological Foundations of Behavior.

NOTE: Students can also take four Survey courses, one of which should be 85-219 Biological Foundations of Behavior.			
03-343	Experimental Techniques in Molecular Biology	12	
09-221	Laboratory I: Introduction to Chemical Analysis	12	
09-222	Laboratory II: Organic Synthesis and Analysis	12	

Research Methods in Psychology Complete one of the following:			
85-310	Research Methods in Cognitive Psychology	9	
85-320	Research Methods in Developmental Psychology	9	
85-340	Research Methods in Social Psychology	9	

Prerequisite for all Research Methods courses: 36-309, and corresponding psychology survey course.

(Note: 36-309 may be taken concurrently as a co-requisite)

Additional Laboratory Requirement:
Complete one additional laboratory experience either as an additional 85-xxx Research Methods course in Psychology or a second laboratory in Biological Sciences at the 300 level or above.

Advanced Psychology/ Biological Sciences Electives 54 Units

1.	Psychology Advanced Elective 1
2.	Psychology Advanced Elective 2
3.	Biology General Elective
4.	Biology Advanced elective 1 (03-360 recommended)
5.	Biology Advanced Elective 2
6.	Advanced Biological Sciences or Psychology Elective,
-	85-3xx or higher (Research recommended)

Additional comments:

If a student drops the unified major program, a second Research Methods course would be required to complete the B.S. in Psychology. If a student drops the unified major program, the following additional courses would be required to complete the B.S. in Biological Sciences: 09-214 Physical Chemistry, 33-xxx Physics II and a second, 300-level Biology laboratory course. This program does not satisfy all of the requirements for pre-medical preparation. Advising is suggested to determine the additional courses needed for that program.

The Undergraduate Additional Major in Human-Computer Interaction

Robert Kraut, Undergraduate Advisor
 Office: Newell Simon Hall (NSH) 3515
 For up to date information, see: www.hcii.cs.cmu.edu/Academics/Undergrad/undergrad.html

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

- Eliciting 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:

85-211	Cognitive Psychology	9
	or 85-213 Human Information Processing and Artificial Intelligence (9 units)	
05-430	Programming Usable Interfaces	430
	or 431 Programming Usable Interfaces	
51-261	Communication Design Fundamentals	9
51-421	Basic Interaction	9
05-410	Human-Computer Interaction Methods	12
05-571	Undergraduate Project in HCI	12

Statistics Requirement:

The Statistics requirement can be satisfied by taking any of the following one or two semester courses, or by receiving credit for courses taken elsewhere.

36-201	Statistical Reasoning and Practice	9
	or	
36-247	Statistics for Lab Sciences	9
	or	
36-220	Engineering Statistics and Quality Control	9
	or	
36-225 & 36-226	Introduction to Probability Theory - Introduction to Probability and Statistics II	9
	or	
36-207	Probability and Statistics for Business Applications	9

Evaluation Requirement: The Evaluation requirement can be satisfied by taking any of the following courses, or by receiving credit for courses taken elsewhere.

36-303	Sampling, Surveys, and Society
36-208	Regression Analysis
36-309	Experimental Design for Behavioral & Social Science
85-310	Research Methods in Cognitive Psychology
85-340	Research Methods in Social Psychology
88-250	Regression Methods in the Social Sciences?
88-251	Empirical Research Methods
70-481	Marketing Research

Electives (18 Units):

From the following list, or by permission from the major advisor:

Design		
51-132	Introduction to Photo Design	4.5
51-202	Intermediate Typography	9
51-222	Color and Communication	9
51-241	How People Work	9
51-242	How Things Work: Mechanics and Electronics	9
51-251	Digital Prototyping	4.5
51-424	Web Portfolio	4.5
51-414	Integrated Product Development	12
76-481	Writing for Multimedia	12
76-479	Marketing, Public Relations, and Corporate Communications	9
76-487	Online Information Design	9
76-491	Rhetorical Analysis	9
80-291	Issues in Multimedia Authoring	9
Computer Science		
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
15-462	Computer Graphics	12
70-459	Web Business Engineering	9
HCI		
05-320	Social Web	12
05-831	Building Virtual Worlds	24
05-395	Applications of Cognitive Science	9
05-410	Human-Computer Interaction Methods	12
05-411	Cognitive Crash Dummies	6

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05-413	Human Factors	9
05-430	Programming Usable Interfaces	6
05-431	Software Structures for User Interfaces	6
05-432	Cognitive Modeling and Intelligent Tutoring Systems	9
05-540	Rapid Prototyping of Computer Systems	12

Human Behavior		
85-370	Perception	9
85-412	Cognitive Modeling	9
05-432	Cognitive Modeling and Intelligent Tutoring Systems	9
70-311	Organizational Behavior	9
70-451	Management Information Systems	9

Multimedia		
80-291	Issues in Multimedia Authoring	9
76-481	Writing for Multimedia	12

Double Counting

All prerequisites can be double counted with any requirements in your primary major. At most three non-prerequisite courses can be double counted with the primary major and the HCI second major. For example, if you are majoring in Cognitive Psychology, then you might want to take 85-211 (Intro to Cognitive Psychology) as one of your three double counts. If more than three of the requirements are already in your primary major, then you must add electives until you have eight HCI courses not required as part of your primary major.

Accelerated Master's Programs

The HCI Institute currently offers a three semester (12-month), 15 course Masters in HCI. Undergraduates who have taken the core courses, and an elective on the 400 level or above will be considered eligible for the Accelerated Masters program. These students, which include all undergraduate HCI majors, can apply for the Accelerated Masters program by November 1st of their Senior year, and can begin the Masters program in the Spring of their Senior year. They can finish the Masters degree after the Summer and Fall.

Admission to the Major

The HCI undergraduate major is currently available only as a second major. Because space is limited in the major's required courses, enrollment in the HCI undergraduate major is currently limited to 25 students in each graduating class. 6 with a primary major in Design, 6 in H&SS, 6 in SCS, and 7 anywhere. Applications are processed once a year, during Spring Break. For more detail, see the website: www.hci.cs.cmu.edu/Academics/Undergrad/undergrad.html

The Minor in Health Care Policy and Management

Sponsored by:

H. John Heinz III College
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
Brenda Peysner, 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

33 Units

Students are required to take the following courses.

79-330	Medicine and Society	9
90-735	Health Economics	12
90-836	Health Systems	6
90-861	Health Policy	6

Elective Courses

27 Units

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
90-853	Healthcare Information Systems	12
90-863	Health Policy II	6

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
85-241	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.

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 new interdisciplinary program leading to a B.S. in Computational Biology. This new degree is a major re-engineering of the current Computational Biology major offered by the department of Biological Sciences (which was one of

the first degree-granting program in Computational Biology in the country). This new degree supplants the old program beginning in 2006.

The goal of this new 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 new program's curriculum, which can be found on the web at <http://www.cs.cmu.edu/~mjs/cb-curriculum.html> 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: 03-231 Biochemistry I and 15-211 Fundamental Data Structures and Algorithms. 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 or Dr. Mark Stehlik at mjs@cs.cmu.edu in Gates Building 5103 no later than the end of October.

Degree Requirements

Math/Stats Core 47 units

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-XXX Math Elective (21-241, 21-260, 21-341)		9
36-XXX Statistics Elective (36-217, 36-225, 36-247, 36-625)		9

General Science Core 41 units

09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
09-217	Organic Chemistry I	9
33-111	Physics I for Science Students	12

Biological Sciences Core 51 units

03-121	Modern Biology	9
03-231	Biochemistry I	9
	or 03-232 Biochemistry I (9 units)	
03-240	Cell Biology	9
03-330	Genetics	9
03-343	Experimental Techniques in Molecular Biology	12
	03-342 is a corequisite for 03-343	
03-201	Undergraduate Colloquium for Sophomores	1
	or 15-128 Freshman Immigration Course (1 units)	
03-411	Topics in Research	1

Computer Science Core 52 units

15-121	Introduction to Data Structures	10
15-123	Effective Programming in C and UNIX	9
15-211	Fundamental Data Structures and Algorithms	12
15-251	Great Theoretical Ideas in Computer Science	12
15-451	Algorithm Design and Analysis	12

Major Electives 45-54 units

03-511	Computational Molecular Biology and Genomics	9
03-XXX or 15-XXX Two Computational Biology Electives		18-24
03-3XX Advanced Biology Elective		9
15-XXX Advanced Computer Science Elective (15-211 or higher)		9

General Education 75 units

99-10x	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument	9
	Elective Cognition, Choice and Behavior	9
	Elective Economics, Political and Social Institutions	9
	Elective Cultural Analysis	9
	Elective Non-technical Elective	9
	Elective Non-technical Elective	9
	Elective Non-technical Elective	9
	Elective Non-technical Elective	9

Free Electives 40-49

Minimum number of units required for degree: 360

BXA Intercollege Degree Programs

<http://www.cmu.edu/interdisciplinary>

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 Humanities and Social Sciences (H&SS). The inter-college 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 H&SS. 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) H&SS 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 H&SS, 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 academic advisor of the BXA Intercollege Degree Programs are the primary advisors and liaisons between CFA and H&SS. 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 H&SS 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

	Units
I. BHA General Education	102
II. H&SS Concentration	72
III. CFA Concentration	108-111
IV. Free Electives	84-87
Total BHA Degree Requirements	369

I. BHA General Education (GenEd)

(12 courses, 102 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 Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester required)

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 discourses. Students examine language for its internal logics and structures.

76-101	Interpretation and Argument -REQUIRED (Various topics by section) www.english.cmu.edu/degrees/courses/courses.html	9
82-xxx	Modern Languages -REQUIRED Complete two courses taught in a language offered by the Modern Language Department. A wide selection of courses are offered in Arabic, Chinese, European Studies, French and Francophone Studies, German, Hispanic Studies, Italian, Japanese, Russian Studies, and Spanish. Students must complete two courses in the same language. Languages taught at other institutions are also acceptable (with advisor approval).	18

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.

79-104	Global Histories -REQUIRED (Various topics by section) www.history.cmu.edu/under/courses.html	9
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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:

<u>Mathematics</u>		
21-110	Problem Solving in Recreational Mathematics	9
21-111	Calculus I	10
21-112	Calculus II *	10
21-120	Differential and Integral Calculus	10
21-121	Integration and Differential Equations *	10

21-122	Integration, Differential Equations and Approximation *	10	85-370	Perception *	9
21-123	Calculus of Approximation *	5	85-392	Human Expertise *	9
21-127	Concepts of Mathematics	9	85-406	Autism: Psychological and Neuroscience Perspectives *	9
21-131	Analysis I *	10	85-412	Cognitive Modeling *	9
21-132	Analysis II *	10	85-414	Cognitive Neuropsychology *	9
21-256	Multivariate Analysis and Approximation *	9	85-419	Introduction to Parallel Distributed Processing *	9
21-259	Calculus in Three Dimensions *	9	85-423	Cognitive Development *	9
80-110	Nature Mathematical Reasoning	9	85-429	Cognitive Brain Imaging	9
80-210	Logic and Proofs	9	88-110	Experiments with Economic Principles	9
80-211	Logic and Mathematical Inquiry	9	88-360	Behavioral Economics *	9
			88-391	Technology and Economic Growth	9
			99-238	Materials, Energy and Environment	9

Natural Science

03-121	Modern Biology	9			
03-122	Organismic Botany *	9			
03-125	Evolution and History of Life *	9			
03-203	Bench to Bedside: Process of Regenerative Therapeutics	6			
03-231	Biochemistry I *	9			
03-232	Biochemistry I *	9			
03-311	Introduction to Computational Molecular Biology *	6			
09-101	Introduction to Experimental Chemistry	3			
09-103	Atoms, Molecules and Chemical Change	9			
09-104	Fundamental Aspects of Organic Chemistry and Biochemistry	9			
09-105	Introduction to Modern Chemistry I	10			
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			
33-106	Physics I for Engineering Students *	12			
33-107	Physics II for Engineering Students *	12			
33-111	Physics I for Science Students *	12			
33-112	Physics II for Science Students *	12			
33-114	Physics of Musical Sound	9			
33-115	Physics for Future Presidents	10			
33-124	Introduction to Astronomy	9			
33-131	Matter and Interaction I *	12			
33-132	Matter and Interactions II *	12			
33-211	Physics III: Modern Essentials *	10			
33-213	Mini-Course in Special Relativity *	4			
33-224	Stars, Galaxies and the Universe *	9			
33-355	Nanoscience and Nanotechnology *	9			

* 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.

36-201	Statistical Reasoning and Practice -REQUIRED	9
36-220	Engineering Statistics and Quality Control	9
36-247	Statistics for Lab Sciences	9
36-303	Sampling, Survey and Society *	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics *	9
79-313	Objects of Value	9
79-342	Introduction to Science and Technology Studies	9
79-354	Religion in American Society	9
80-130	Introduction to Ethics	9
80-136	Social Structure, Public Policy & Ethics	9
80-208	Critical Thinking	9
80-221	Philosophy of Social Science	9
80-230	Ethical Theory	9
80-235	Political Philosophy	9
80-241	Ethical Judgments in Professional Life	9
80-242	Conflict and Dispute Resolution	9
80-243	Business Ethics	6
80-244	Environmental Ethics	9
80-245	Medical Ethics	9
80-270	Philosophy of Mind	9
80-305	Rational Choice	9
80-321	Causation, Law, and Social Policy *	9
80-341	Computers, Society and Ethics	9
80-447	Global Justice	9
85-102	Introduction to Psychology	9
85-211	Cognitive Psychology	9
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
85-261	Abnormal Psychology	9
85-395	Applications of Cognitive Science *	9
88-104	Decision Processes in American Political Institutions	9
88-120	Reason, Passion and Cognition	9
88-365	Behavioral Economics and Public Policy	9
88-386	Desires and Decisions	9

* Indicates co-requisites and/or prerequisites required.

BXA Freshman Research Seminar (1 course, 9 units)

This course introduces freshmen in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic,

Other Courses

05-291	HCI for Computer Scientists *	12
05-413	Human Factors	9
06-100	Introduction to Chemical Engineering *	12
09-109	Kitchen Chemistry Sessions	3
09-209	Kitchen Chemistry Sessions *	3
12-100	Introduction to Civil and Environmental Engineering *	12
15-102	Exploring Programming with Graphics	10
15-105	Principles of Computation	9
15-110	Principles of Computing	10
15-121	Introduction to Data Structures	10
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
36-202	Statistical Methods *	9
36-350	Data Mining *	9
42-101	Introduction to Biomedical Engineering	12
79-382	History of Biomedical Research	9
80-220	Philosophy of Science	9
80-226	Revolutions in Science	9
80-312	Philosophy of Mathematics	9
80-313	Philosophical Logic	9
80-322	Philosophy of Physics	9
80-323	Philosophy of Biology	9
85-355	Introduction to Cognitive Neuroscience *	9

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scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers.

62-190 BXA Freshman Research Seminar -REQUIRED 9

BXA Capstone Project (2 courses, 18 units)

The goal of the BXA Capstone Project is to give BHA students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The project's goals are based on the student's curriculum that is based in part on their interdisciplinary "vision" in the arts and humanities/social sciences.

62-401 BXA Capstone Project -Fall -REQUIRED (DNM, by appointment with instructor) 9

62-402 BXA Capstone Project -Spring -REQUIRED (course attendance required) 9

Computing @ Carnegie Mellon (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-101 Computing @ Carnegie Mellon -REQUIRED 3
 or99-102 Computing @ Carnegie Mellon (3 units)
 or99-103 Computing @ Carnegie Mellon (3 units)

II. College of Humanities and Social Sciences Concentration

(8 courses, 72 units minimum)

Each student meets individually with a BHA H&SS Academic Advisor to design a 72-unit H&SS concentration based on existing H&SS majors/minors, or by creating a self-defined interdepartmental concentration. Please refer to the H&SS section of this catalog to review the individual majors and minors offered.

III. College of Fine Arts Concentration

(number of courses vary, 108-111 units minimum)

BHA students choose one of the following concentrations:

- Architecture (108-111 units)
- Art (108 units)
- Design (108 units)
- Drama (108 units)
- Music (108 units)

Architecture Concentration (108-111 units minimum)

Architecture Required Courses (54 units minimum)

48-100 Architecture Design Studio: Foundation I 12
 or48-095 Architecture for Non-Majors I (9 units)
 48-130 Architectural Drawing I: A Tactile Foundation 9
 48-135 Architectural Drawing II: Appearance 9
 48-240 Historical Survey of World Architecture and Urbanism 9
 48-34x Architectural History Lecture (varying topics) 9
 48-44x Architectural History Lecture (varying topics) 9

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54-57 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-120 Introduction to Digital Media I 6
 48-210 Statics (prerequisite: 33-106 or 48-116) 9
 48-215 Materials and Assembly (prerequisite: 48-210) 9
 48-217 Structures (prerequisite: 48-210) 9
 48-3xx Drawing Elective 9
 48-315 Environment I: Climate & Energy (prerequisite: 33-106 or 48-116) 9

48-351 Human Factors in Architecture 9
 48-34x Architectural History Lecture (varying topics) 9
 48-44x Architectural History Lecture (varying topics) 9
 48-452 Real Estate Design and Development 9
 48-453 Urban Design Methods 9
 48-551 Ethics and Decision Making in Architecture 9
 48-5xx Departmental Elective (prerequisites vary) 9

Elective Focus: Architectural Representation and Visualization (57 units)

This sequence is intended to develop particular skills in architectural representation.

48-120 Introduction to Digital Media I 6
 48-125 Introduction to Digital Media II 6
 48-3xx Drawing Elective 9
 48-xxx Undergraduate Representation/Visualization Elective (pre-approval of coursework required) 18
 48-xxx Graduate Representation/Visualization Elective (pre-approval of coursework required) 18

Elective Focus: Architectural Technology (54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

33-106 Physics I for Engineering Students 12
 or48-116 Building Physics (9 units)
 62-175 Descriptive Geometry 6

Elective Courses:

48-210 Statics (prerequisite: 33-106 or 48-116) 9
 48-215 Materials and Assembly (prerequisite: 48-210) 9
 48-217 Structures (prerequisite: 48-210) 9
 48-315 Environment I: Climate & Energy (prerequisite: 33-106 or 48-116) 9
 48-410 Environment II: Lighting (prerequisite: 33-106 or 48-116, in conjunction with studio) 6
 48-412 Environment II: Mechanical Systems 9
 48-415 Advanced Building Systems (prerequisite: 48-315, in conjunction with studio) 6
 48-4xx Designated Departmental Technical Elective 9

Elective Focus: Architectural History (six varying topics, 54 units)

48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9

Art Concentration (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101 Concept Studio I 10
 60-201 Concept Studio III 10
 (renamed Concept Studio II S'11)
 60-202 Concept Studio III 10
 60-203 Concept Studio: EcoArt 10
 60-204 Concept Studio: Networked Narrative 10

Media Studios (3 courses, 30 units)
Complete three courses:

60-150	2D Media Studio: Drawing	10
60-160	2D Media Studio: Imaging	10
60-250	2D Media Studio: Painting	10
60-130 & 60-130	3-D Media Studio I-I (complete two minis, 5 units each)	10
60-131 & 60-131	3D Media Studio II-II (complete two minis, 5 units each)	10
60-110	Electronic Media Studio I	10
60-210	Electronic Media Studio II	10

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 PDP). 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)	10
60-430 - 60-447	Advanced Sculpture, Installation and Site-Work (SIS)	10
60-448 - 60-449	Advanced Contextual Practice (CP)	10
60-450 - 60-498	Advanced Painting, Drawing and Printmaking (PDP)	10
60-499	Studio Independent Study (one only)	10

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture 1789-1945	9
60-206	Contemporary Visual Culture from 1945 to the Present	9

Review Requirement (Complete 2 required reviews, 0 units)
A review is required at the end of the sophomore and senior years. Pass/fail only.

60-200	Sophomore Review -Spring	0
60-400	Senior Review -Spring	0

Design Concentration (108 Units Minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (72 units)

51-101	Design Studio I -Fall	9
51-102	Design Studio II -Spring	9
51-121	Design Drawing I -Fall	9
51-122	Design Drawing II -Spring	9
51-132 & 51-134	Introduction to Photo Design - Photo Design II - Spring	9
51-171	Human Experience in Design -Fall	9
51-271	Design History I -Fall	9
62-100	Critical Histories of the Art	9

Design Electives (36 units)

Choose four (4) additional Design courses at the sophomore, junior and senior levels in consultation with the Design advisor.

NOTE: BHA Design students have 87 units of electives built into their program, any portion of which can be taken in Design. These additional courses must also be chosen in consultation with the Design advisor and respect all prerequisite requirements, etc.

Drama Concentration (108 units minimum)

AUCTION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY CONCENTRATION OPTIONS. PORTFOLIO REVIEW/ INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTIONS.

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 (14 units)

54-175 & 54-176	Conservatory Hour-Conservatory Hour (1 unit each)	2
54-177	Foundations of Drama I	6
or 54-178	Foundations of Drama I (6 units)	
54-281	Foundations of Drama II	6
or 54-282	Foundations of Drama II (6 units)	

Work with Drama Advisor to Form Concentration Option (94 units minimum):

Design Required Courses (26 units)

54-151 & 54-152	Stagecraft-Stagecraft (15 units + 11 units)	26
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Choose 68 additional Design units in consultation with the Design advisor.

Directing Required Courses (49-52 units)

54-121 & 54-122	Directing I: Sources-Directing I: Sources	18
54-221 & 54-222	Directing II: Fundamentals-Directing II: Fundamentals (6 or 9 units + 9 units)	18
54-159 & 54-160	Production Symposium I-I	12
54-517 & 54-518	Director's Colloquium-Director's Colloquium (four times, 4 units total)	2

Choose 42-45 additional Directing units in consultation with the Directing advisor.

Dramaturgy Required Courses (53-64 units)

54-109	Dramaturgy I: Approaches to Text	9
54-184	Dramaturgy 2: History and Practice	9
54-160	Production Symposium I -Spring	6
54-200	Ghost Light Forum (four times, 4 units total)	1
54-299	Dramaturgy Production I (1-12 units)	Var.
54-381	History of Drama	6
or 54-382	History of Drama (3 units) and	
54-382	History of Drama (3 units)	
54-xxx	Dramaturgy 3/4/5/6 (may be taken in any order in the sophomore, junior, and senior year)	18

Choose 30-41 additional Dramaturgy units in consultation with the Dramaturgy advisor.

Production Technology and Management Required Courses (26 units)

54-151 & 54-152	Stagecraft-Stagecraft (15 units + 11 units)	26
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Choose 68 additional PTM units in consultation with the PTM advisor.

NOTE: BHA Drama students have 87 units of electives built into their program, any portion of which can be taken in Drama. These additional courses must also be chosen in consultation with the Drama advisor, given the appropriate prerequisites are in place and with permission of instructors where necessary.

Music Concentration (108 units minimum)

AUCTION AND INTERVIEW REQUIRED FOR MUSIC PERFORMANCE CONCENTRATION OPTION. INTERVIEW REQUIRED FOR MUSIC HISTORY AND CULTURE OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music Performance (instrumental, piano, organ, composition, voice) , 2) Music History and Culture, 3) Music Technology

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Required Courses for All Concentration Options (21 units)

57-152	Harmony I	9
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3

Music Performance Required Courses (66 units)

57-xxx	BXA Studio (4 semesters)	36
57-xxx	Major Ensemble (4 semesters)	24
57-161	Eurhythmics I	3
57-181	Solfege I	3

Choose 21 units from:

57-153	Harmony II	9
57-162	Eurhythmics II	3
57-163	Eurhythmics III	3
57-164	Eurhythmics IV	3
57-182	Solfege II	3
57-183	Solfege III	3
57-184	Solfege IV	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3

Music History and Culture Required Courses (27 units minimum)

57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3
57-611	Independent Study in History (3, 6, or 9 units)	Var.

Choose 36 units from:

57-209	The Beatles	9
57-306	World Music	6
57-412	Opera Since Wagner	9
57-414	Music and Nature	9
57-477	Music of the Spirit	6
57-478	Survey of Historical Recording	6
57-480	History of Black American Music	6

Choose 24 additional Music units in consultation with the Music advisor.

Music Technology Required Courses (30 units)

57-101	Introduction to Music Technology	6
57-181	Solfege I	3
57-337	Sound Recording	6
57-347	Electronic and Computer Music	6
57-xxx	Independent Study in Music Technology or Sound Recording	9

Choose 36 units from:

57-153	Harmony II	9
57-182	Solfege II	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3
57-338	Sound Editing and Mastering	6
57-438	Multitrack Recording	9

Choose 21 additional Music units in consultation with the Music advisor.

* co-requisite for Music History I and II

Interdisciplinary Concentration (108 units minimum)

BHA students may combine a minimum of 108 units from two or more areas in the fine arts, with a complementary 72 units from two or more areas in the humanities and/or social sciences. Interdisciplinary areas to consider: arts and society, visual and verbal communication, the arts and organizations, performance and theory, comparative arts.

IV. Free Electives

(approximately 10 courses, 87 units)

Take any Carnegie Mellon course. Many BHA students use their electives to broaden or deepen their concentrations. 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 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.

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 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

	Units
I. BSA Core	126
II. MCS Concentration	120-135
III. CFA Concentration	108-111
IV. Free Electives	8-26
Total BSA Degree Requirements	380

I. BSA Core

(14 courses, 126 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)
- 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 Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester required)

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.

76-101 Interpretation and Argument -REQUIRED 9
(Various topics by section) www.english.cmu.edu/degrees/courses/courses.html

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.

57-173	Survey of Western Music History	9
70-342	Managing Across Cultures *	9
76-227	Comedy	9
76-232	African American Literature	9
76-241	Introduction to Gender Studies	9
79-104	Global Histories	9
79-112	Race, Nationality, and Culture in American Society	9
79-113	Culture and Identity in American Society	9
79-207	Development of European Culture	9
79-240	The Development of American Culture	9
79-241	African American History I	9
79-242	African American History II	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
79-330	Medicine and Society	9
79-332	Medical Anthropology	9
79-345	The Roots of Rock and Roll, 1870-1970	9
79-368	Poverty, Charity, and Welfare	9
80-100	Introduction to Philosophy	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
82-2xx	Any 200 level or greater course from Modern Languages	9

* Indicates co-requisites and/or pre-requisites required.

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.

36-303	Sampling, Survey and Society *	9
70-332	Business, Society and Ethics *	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
73-200	Intermediate Macroeconomics	9

79-330	Medicine and Society	9
79-332	Medical Anthropology	9
79-335	Drug Use and Drug Policy	9
79-374	American Environmental History: Critical Issues	9
79-392	History of Modern Warfare	9
80-135	Introduction to Political Philosophy	9
80-136	Social Structure, Public Policy & Ethics	9
80-226	Revolutions in Science	9
80-235	Political Philosophy	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

* Indicates co-requisites and/or pre-requisites required.

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.

80-130	Introduction to Ethics	9
80-150	Nature of Reason	9
80-180	The Nature of Language	9
80-208	Critical Thinking	9
80-220	Philosophy of Science	9
80-221	Philosophy of Social Science	9
80-230	Ethical Theory	9
80-241	Ethical Judgments in Professional Life	9
80-242	Conflict and Dispute Resolution	9
80-270	Philosophy of Mind	9
85-102	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
85-421	Language and Thought	9
88-120	Reason, Passion and Cognition	9

Complete TWO additional courses from one of the following departments (2 courses, complete 18 units minimum)

- English
- History
- Modern Languages
- Philosophy
- Psychology

Mathematics (2 courses, 20 units)

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10

Science (3 courses, 31 units)

03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry I	10
33-111	Physics I for Science Students	12

BXA Freshman Research Seminar (1 course, 9 units)

This course introduces freshmen in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the

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systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers.

62-190 BXA Freshman Research Seminar -REQUIRED 9

BXA Capstone Project (2 courses, 18 units)

The goal of the BXA Capstone Project is to give BSA students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The project's goals are based on the student's curriculum that is based in part on their interdisciplinary "vision" in the arts and physical/natural sciences.

62-401 BXA Capstone Project -Fall -REQUIRED (DNM, by appointment with instructor) 9

62-402 BXA Capstone Project -Spring -REQUIRED (course attendance required) 9

Computing @ Carnegie Mellon (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-101 Computing @ Carnegie Mellon -REQUIRED 3
 or99-102 Computing @ Carnegie Mellon (3 units)
 or99-103 Computing @ Carnegie Mellon (3 units)

II. MCS Concentration

(number of courses vary, 120-135 units)

BSA students choose one of the following concentrations:

- Biological Sciences (120-123 units)
- Chemistry (124 units)
- Mathematical Sciences (121 units)
- Physics (132-135 units)

Biological Sciences Concentration (120-123 units minimum)

Biological Sciences Required Courses (102 units minimum)

03-231	Biochemistry I	9
	or03-232 Biochemistry I (9 units)	
03-240	Cell Biology	9
03-330	Genetics	9
03-124	Modern Biology Laboratory	9
	or03-343 Experimental Techniques in Molecular Biology (12 units)	
03-201	Undergraduate Colloquium for Sophomores (2 units) &/or	Var.
	or03-202 Undergraduate Colloquium for Sophomores	
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 II	10
09-214	Physical Chemistry	9
	or09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry (9 units)	
	or09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry (9 units)	
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
09-201 & 09-202 & 09-301	Undergraduate Seminar I - Undergraduate Seminar II: Safety and Environmental Issues for Chemists - Undergraduate Seminar III	3
09-402	Undergraduate Seminar VI	3
33-112	Physics II for Science Students	12

Advanced Chemistry Electives (2 courses, 18 units)
 May be any upper level chemistry course, 09-3xx or higher, or Biochemistry I, 03-231 or 03-232, with the exception of 09-435 Independent Study, which can be used only by permission of the Director of Undergraduate Studies.

Mathematical Sciences Concentration (121 units minimum)

Mathematical Sciences Required Courses (85 units)

15-110	Principles of Computing	10
21-127	Concepts of Mathematics (prerequisite for 15-211)	9
21-228	Discrete Mathematics	9
21-241	Matrix Algebra	9
	or21-341 Linear Algebra (9 units)	
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 II 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 course at the level of 36-225 or higher.

Physics Concentration (132-135 units minimum)

Physics Required Courses (114 units)

21-259	Calculus in Three Dimensions	9
33-104	Experimental Physics	9
33-112	Physics II for Science Students	12
33-201	Physics Sophomore Colloquium I - Fall	2
33-202	Physics Sophomore Colloquium II - Spring	2
33-211	Physics III: Modern Essentials	10
33-228	Electronics I	10
33-231	Physical Analysis	9
33-232	Mathematical Methods of Physics	9
33-234	Quantum Physics	10
33-301	Physics Upperclass Colloquium I - Fall	1
33-302	Physics Upperclass Colloquium II - Spring	1
33-331	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, 18-21 units)

Two courses to be pre-approved by the Physics Department.

33-xxx Two Physics Electives 18-21

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, 108-111 units minimum)

BSA students choose one of the following concentrations:

- Architecture (108-111 units)
- Art (108 units)
- Design (108 units)
- Drama (108 units)
- Music (108 units)

Architecture Concentration (108-111 units minimum)

Architecture Required Courses (54 units minimum)

48-100	Architecture Design Studio: Foundation I or 48-095 Architecture for Non-Majors I (9 units)	12
48-130	Architectural Drawing I: A Tactile Foundation	9
48-135	Architectural Drawing II: Appearance	9
48-240	Historical Survey of World Architecture and Urbanism	9
48-34x	Architectural History Lecture (varying topics)	9
48-44x	Architectural History Lecture (varying topics)	9

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54-57 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-120	Introduction to Digital Media I	6
48-210	Statics (prerequisite: 33-106 or 48-116)	9
48-215	Materials and Assembly (prerequisite: 48-210)	9
48-217	Structures (prerequisite: 48-210)	9
48-3xx	Drawing Elective	9
48-315	Environment I: Climate & Energy (prerequisite: 33-106 or 48-116)	9
48-351	Human Factors in Architecture	9
48-34x	Architectural History Lecture (varying topics)	9
48-44x	Architectural History Lecture (varying topics)	9
48-452	Real Estate Design and Development	9
48-453	Urban Design Methods	9
48-551	Ethics and Decision Making in Architecture	9
48-5xx	Departmental Elective (prerequisites vary)	9

Elective Focus: Architectural Representation and Visualization (57 units)

This sequence is intended to develop particular skills in architectural representation.

48-120	Introduction to Digital Media I	6
48-125	Introduction to Digital Media II	6
48-3xx	Drawing Elective	9
48-xxx	Undergraduate Representation/Visualization Elective (pre-approval of coursework required)	18
48-xxx	Graduate Representation/Visualization Elective (pre-approval of coursework required)	18

Elective Focus: Architectural Technology (54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

33-106	Physics I for Engineering Students or 48-116 Building Physics (9 units)	12
62-175	Descriptive Geometry	6

Elective Courses:

48-210	Statics (prerequisite: 33-106 or 48-116)	9
48-215	Materials and Assembly (prerequisite: 48-210)	9
48-217	Structures (prerequisite: 48-210)	9
48-315	Environment I: Climate & Energy (prerequisite: 33-106 or 48-116)	9

48-410	Environment II: Lighting (prerequisite: 33-106 or 48-116, in conjunction with studio)	6
48-412	Environment II: Mechanical Systems	9
48-415	Advanced Building Systems (prerequisite: 48-315, in conjunction with studio)	6
48-4xx	Designated Departmental Technical Elective	9

Elective Focus: Architectural History (Six varying topics, 54 units)

48-34x	/44x Architectural History	9
48-34x	/44x Architectural History	9
48-34x	/44x Architectural History	9
48-34x	/44x Architectural History	9
48-34x	/44x Architectural History	9
48-34x	/44x Architectural History	9

Art Concentration (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101	Concept Studio I	10
60-201	Concept Studio III (renamed Concept Studio II S'11)	10
60-202	Concept Studio III	10
60-203	Concept Studio: EcoArt	10
60-204	Concept Studio: Networked Narrative	10

Media Studios (3 courses, 30 units)

Complete three courses:

60-150	2D Media Studio: Drawing	10
60-160	2D Media Studio: Imaging	10
60-250	2D Media Studio: Painting	10
60-130 & 60-130	3-D Media Studio I-I (complete two minis, 5 units each)	10
60-131 & 60-131	3D Media Studio II-II (complete two minis, 5 units each)	10
60-110	Electronic Media Studio I	10
60-210	Electronic Media Studio II	10

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 PDP). 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)	10
60-430 - 60-447	Advanced Sculpture, Installation and Site-Work (SIS)	10
60-448 - 60-449	Advanced Contextual Practice (CP)	10
60-450 - 60-498	Advanced Painting, Drawing and Printmaking (PDP)	10
60-499	Studio Independent Study (one only)	10

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture 1789-1945	9
60-206	Contemporary Visual Culture from 1945 to the Present	9

Review Requirement (Complete 2 required reviews, 0 units)

A review is required at the end of the sophomore and senior years. Pass/fail only.

60-200	Sophomore Review -Spring	0
60-400	Senior Review -Spring	0

Design Concentration (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (72 units)

51-101	Design Studio I -Fall	9
51-102	Design Studio II -Spring	9
51-121	Design Drawing I -Fall	9
51-122	Design Drawing II -Spring	9
51-132 & 51-134	Introduction to Photo Design - Photo Design II -Spring	9
51-171	Human Experience in Design -Fall	9
51-271	Design History I -Fall	9
62-100	Critical Histories of the Art	9

Design Electives (36 units)

Choose four (4) additional Design courses at the sophomore, junior, and senior levels in consultation with the Design advisor.

Drama Concentration (108 units minimum)

AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY CONCENTRATION OPTIONS. PORTFOLIO REVIEW/ INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTIONS.

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 (14 units)

54-175 & 54-176	Conservatory Hour-Conservatory Hour (1 unit each)	2
54-177	Foundations of Drama I	6
	or54-178 Foundations of Drama I (6 units)	
54-281	Foundations of Drama II	6
	or54-282 Foundations of Drama II (6 units)	

Work with Drama Advisor to Form Concentration Option (94 units minimum):

Design Required Courses (26 units)

54-151 & 54-152	Stagecraft-Stagecraft (15 units + 11 units)	26
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Choose 68 additional Design units in consultation with the Design advisor.

Directing Required Courses (49-52 units)

54-121 & 54-122	Directing I: Sources-Directing I: Sources	18
54-221 & 54-222	Directing II: Fundamentals-Directing II: Fundamentals	18
	(6 or 9 units + 9 units)	
54-159 & 54-160	Production Symposium I-I	12
54-517 & 54-518	Director's Colloquium-Director's Colloquium (four times, 4 units total)	2

Choose 42-45 additional Directing units in consultation with the Directing advisor.

Dramaturgy Required Courses (53-64 units)

54-109	Dramaturgy I:Approaches to Text	9
54-184	Dramaturgy 2: History and Practice	9
54-160	Production Symposium I - Spring	6
54-200	Ghost Light Forum	1
	(four times, 4 units total)	
54-299	Dramaturgy Production I (1-12 units)	Var.

54-381	History of Drama	6
	or54-382 History of Drama (3 units) and	
	54-382 History of Drama (3 units)	
54-xxx	Dramaturgy 3/4/5/6 (may be taken in any order in the sophomore, junior, and senior year)	18

Choose 30-41 additional Dramaturgy units in consultation with the Dramaturgy advisor.

Production Technology and Management Required Courses (26 units)

54-151 & 54-152	Stagecraft-Stagecraft (15 units + 11 units)	26
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Choose 68 additional PTM units in consultation with the PTM advisor.

Music Concentration (108 units minimum)

AUDITION AND INTERVIEW REQUIRED FOR MUSIC PERFORMANCE CONCENTRATION OPTION. INTERVIEW REQUIRED FOR MUSIC HISTORY AND CULTURE OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music Performance (instrumental, piano, organ, composition, voice), 2) Music History and Culture, 3) Music Technology

Required Courses for All Concentration Options (21 units)

57-152	Harmony I	9
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3

Music Performance Required Courses (66 units)

57-xxx	BXA Studio (4 semesters)	36
57-xxx	Major Ensemble (4 semesters)	24
57-161	Eurhythmics I	3
57-181	Solfege I	3

Choose 21 units from:

57-153	Harmony II	9
57-162	Eurhythmics II	3
57-163	Eurhythmics III	3
57-164	Eurhythmics IV	3
57-182	Solfege II	3
57-183	Solfege III	3
57-184	Solfege IV	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3

Music History and Culture Required Courses (27 units minimum)

57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3
57-611	Independent Study in History (3, 6, or 9 units)	Var.

Choose 36 units from:

57-209	The Beatles	9
57-306	World Music	6
57-412	Opera Since Wagner	9
57-414	Music and Nature	9
57-477	Music of the Spirit	6
57-478	Survey of Historical Recording	6
57-480	History of Black American Music	6

Choose 24 additional Music units in consultation with the Music advisor.

Music Technology Required Courses (30 units)

57-101	Introduction to Music Technology	6
57-181	Solfege I	3
57-337	Sound Recording	6
57-347	Electronic and Computer Music	6
57-xxx	Independent Study in Music Technology or Sound Recording	9

Choose 36 units from:

57-153	Harmony II	9
57-182	Solfege II	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3
57-338	Sound Editing and Mastering	6
57-438	Multitrack Recording	9

Choose 21 additional Music units in consultation with the Music advisor.

* co-requisite for Music History I and II

IV. Free Electives

(approximately 1-3 courses, 8-26 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 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 for their fine arts concentration, and an advisor in SCS for their computer science concentration. This network of advisors guides each student through their curriculum.

BCSA Curriculum

	Units
I. BCSA Core	112
II. SCS Concentration	110
III. CFA Concentration	108-118
IV. BCSA Free Electives	40-50
Total BCSA Degree Requirements	380

I. BCSA Core

(14 courses, 112 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 Capstone Project (2 courses, 18 units, 62-401 & 62-402 required)
- Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester required)

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.

76-101	Interpretation and Argument - REQUIRED (various topics by section, see http://www.cmu.edu/degrees/courses/courses.html)	9
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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.

57-173	Survey of Western Music History	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
79-240	The Development of American Culture	9
79-241	African American History I	9
79-242	African American History II	9
79-261	Chinese Culture and Society	9
79-281	Introduction to Religion	9
79-311	Introduction to Anthropology	9
79-330	Medicine and Society	9
79-345	The Roots of Rock and Roll, 1870-1970	9
79-350	Early Christianity	9
79-354	Religion in American Society	9
79-368	Poverty, Charity, and Welfare	9
80-100	Introduction to Philosophy	9
80-250	Ancient Philosophy	9
80-251	Modern Philosophy	9
80-253	Continental Philosophy	9

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80-254	Analytic Philosophy	9
80-255	Pragmatism	9
80-276	Philosophy of Religion	9
82-3xx	Any 300 level or greater course from Modern Languages	

Mathematics & Probability (3 courses, 28 units minimum)

Choose two mathematics courses (19 units minimum):

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
or 21-241 Matrix Algebra (9 units)		

Choose one probability course (9 units minimum):

15-359	Probability and Computing	12
21-325	Probability	9
36-217	Probability Theory and Random Processes	9
36-225	Introduction to Probability Theory	9
36-625	Probability and Mathematical Statistics I	12

Science (2 courses, 18 units minimum)

Choose two courses from the following list:

03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry I	10
21-259	Calculus in Three Dimensions	9
33-111	Physics I for Science Students	12

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.

36-303	Sampling, Survey and Society	9
70-332	Business, Society and Ethics	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
79-335	Drug Use and Drug Policy	9
79-374	American Environmental History: Critical Issues	9
80-135	Introduction to Political Philosophy	9
80-136	Social Structure, Public Policy & Ethics	9
80-235	Political Philosophy	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

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.

70-311	Organizational Behavior	9
80-130	Introduction to Ethics	9
80-150	Nature of Reason	9
80-180	The Nature of Language	9
80-221	Philosophy of Social Science	9
80-230	Ethical Theory	9
80-241	Ethical Judgments in Professional Life	9

80-242	Conflict and Dispute Resolution	9
80-270	Philosophy of Mind	9
80-275	Metaphysics	9
80-281	Language and Thought	9
85-100	Introduction to Intelligence in Humans, Animals and Machines	9
85-102	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

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)

This course introduces freshmen and sophomore students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers.

62-190	BXA Freshman Research Seminar -REQUIRED	9
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BXA Capstone Project (2 courses, 18 units)

The goal of the BXA Capstone Project is to give BCSA students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The project's goals are based on the student's curriculum that is based in part on their interdisciplinary "vision" in the arts and computer science.

62-401	BXA Capstone Project -Fall -REQUIRED (DNM, by appointment with instructor)	9
62-402	BXA Capstone Project -Spring -REQUIRED (course attendance required)	9

Computing @ Carnegie Mellon (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-101	Computing @ Carnegie Mellon -REQUIRED	3
or 99-102 Computing @ Carnegie Mellon (3 units)		
or 99-103 Computing @ Carnegie Mellon (3 units)		

II. SCS Concentration

School Of Computer Science Concentration (110 units minimum)

Computer Science Core Requirements (56 units)

15-121	Introduction to Data Structures	10
15-123	Effective Programming in C and UNIX	9
15-128	Freshman Immigration Course	1
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
or 15-213 Introduction to Computer Systems (12 units)		
15-251	Great Theoretical Ideas in Computer Science	12

Concepts of Mathematics (9 units)

21-127 Concepts of Mathematics (prerequisite for 15-211) 9

Applications Courses or CS Electives (5 courses, 45 units minimum)
Choose a minimum of five courses from the following list:

11-411 Natural Language Processing 12
 15-312 Foundations of Programming Languages 12
 15-313 Foundations of Software Engineering 12
 15-322 Introduction to Computer Music 9
 15-323 Computer Music Systems and Information Processing 9
 15-381 Artificial Intelligence: Representation and Problem Solving 9
 15-384 Robotic Manipulation 12
 15-385 Computer Vision 9
 15-413 Software Engineering Practicum 12
 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
 Others as appropriate with advisor's permission.

Elective Focus: Architectural Representation and Visualization (57 units)

This sequence is intended to develop particular skills in architectural representation.

48-120 Introduction to Digital Media I 6
 48-125 Introduction to Digital Media II 6
 48-3xx Drawing Elective 9
 48-xxx Undergraduate Representation/Visualization Elective (pre-approval of coursework required) 18
 48-xxx Graduate Representation/Visualization Elective (pre-approval of coursework required) 18

Elective Focus: Architectural Technology (54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

33-106 Physics I for Engineering Students 12
 or 48-116 Building Physics (9 units)
 62-175 Descriptive Geometry 6

Elective Courses:

48-210 Statics (prerequisite: 33-106 or 48-116) 9
 48-215 Materials and Assembly (prerequisite: 48-210) 9
 48-217 Structures (prerequisite: 48-210) 9
 48-315 Environment I: Climate & Energy (prerequisite: 33-106 or 48-116) 9
 48-410 Environment II: Lighting (prerequisite: 33-106 or 48-116, in conjunction with studio) 6
 48-412 Environment II: Mechanical Systems 9
 48-415 Advanced Building Systems (prerequisite: 48-315, in conjunction with studio) 6
 48-4xx Designated Departmental Technical Elective 9

III. College of Fine Arts Concentration

(number of courses vary, 108-118 units minimum)

BCSA students choose one of the following concentrations:

- Architecture (108-111 units)
- Art (118 units)
- Design (108 units)
- Drama (108 units)
- Music (108 units)

Architecture Concentration (108-111 units minimum)

Architecture Required Courses (54 units minimum)

48-100 Architecture Design Studio: Foundation I 12
 or 48-095 Architecture for Non-Majors I (9 units)
 48-130 Architectural Drawing I: A Tactile Foundation 9
 48-135 Architectural Drawing II: Appearance 9
 48-240 Historical Survey of World Architecture and Urbanism 9
 48-34x Architectural History Lecture (varying topics) 9
 48-44x Architectural History Lecture (varying topics) 9

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54-57 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-120 Introduction to Digital Media I 6
 48-210 Statics (prerequisite: 33-106 or 48-116) 9
 48-215 Materials and Assembly (prerequisite: 48-210) 9
 48-217 Structures (prerequisite: 48-210) 9
 48-3xx Drawing Elective 9
 48-315 Environment I: Climate & Energy (prerequisite: 33-106 or 48-116) 9
 48-351 Human Factors in Architecture 9
 48-34x Architectural History Lecture (varying topics) 9
 48-44x Architectural History Lecture (varying topics) 9
 48-452 Real Estate Design and Development 9
 48-453 Urban Design Methods 9
 48-551 Ethics and Decision Making in Architecture 9
 48-5xx Departmental Elective (prerequisites vary) 9

Elective Focus: Architectural History (Six varying topics, 54 units)

48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9
 48-34x /44x Architectural History 9

Art Concentration (118 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101 Concept Studio I 10
 60-201 Concept Studio III 10
 (renamed Concept Studio II S'11)
 60-202 Concept Studio III 10
 60-203 Concept Studio: EcoArt 10
 60-204 Concept Studio: Networked Narrative 10

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Media Studios (2 courses, 20 units)
Complete two courses:

60-110	Electronic Media Studio I	10
60-150	2D Media Studio: Drawing	10
60-160	2D Media Studio: Imaging	10
60-250	2D Media Studio: Painting	10
60-130 & 60-130	3-D Media Studio I-I (complete two minis, 5 units each)	10
60-131 & 60-131	3D Media Studio II-II (complete two minis, 5 units each)	10
60-210	Electronic Media Studio II	10

Advanced Media 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 PDP). 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)	10
60-430 - 60-447	Advanced Sculpture, Installation and Site-Work (SIS)	10
60-448 - 60-449	Advanced Contextual Practice (CP)	10
60-450 - 60-498	Advanced Painting, Drawing and Printmaking (PDP)	10
60-499	Studio Independent Study (one only)	10

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture 1789-1945	9
60-206	Contemporary Visual Culture from 1945 to the Present	9

Review Requirement (Complete 2 required reviews, 0 units)
A review is required at the end of the sophomore and senior years. Pass/fail only.

60-200	Sophomore Review -Spring	0
60-400	Senior Review -Spring	0

Design Concentration (108 units minimum)
PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (72 units)

51-101	Design Studio I -Fall	9
51-102	Design Studio II -Spring	9
51-121	Design Drawing I -Fall	9
51-122	Design Drawing II -Spring	9
51-132 & 51-134	Introduction to Photo Design - Photo Design II -Spring	9
51-171	Human Experience in Design -Fall	9
51-271	Design History I -Fall	9
62-100	Critical Histories of the Art	9

Design Electives (36 units)

Choose four (4) additional Design courses at the sophomore, junior and senior levels in consultation with the Design advisor.

Drama Concentration (108 units minimum)

AUDITION/INTERVIEW REQUIRED FOR DIRECTING CONCENTRATION OPTION. PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR PRODUCTION TECHNOLOGY AND MANAGEMENT CONCENTRATION OPTION.

Options available in the following Areas: 1) Directing, 2) Production Technology and Management

Required Courses for Both Concentration Options (14 units)

54-175 & 54-176	Conservatory Hour-Conservatory Hour (1 unit each)	2
54-177	Foundations of Drama I	6
or 54-178	Foundations of Drama I (6 units)	
54-281	Foundations of Drama II	6
or 54-282	Foundations of Drama II (6 units)	

Work with Drama Advisor to Form Concentration Option (94 units minimum):

Directing Required Courses (49-52 units)

54-121 & 54-122	Directing I: Sources-Directing I: Sources	18
54-221 & 54-222	Directing II: Fundamentals-Directing II: Fundamentals (6 or 9 units + 9 units)	18
54-159 & 54-160	Production Symposium I-I	12
54-517 & 54-518	Director's Colloquium-Director's Colloquium (four times, 4 units total)	2

Choose 42-45 additional Directing units in consultation with the Directing advisor.

Production Technology and Management Required Courses (94 units)

54-151 & 54-152	Stagecraft-Stagecraft (15 units + 11 units)	26
54-157 & 54-158	Basic PTM-Basic PTM	12
54-169 & 54-170	Studiocraft-Studiocraft (13 units + 8 units)	21
54-271	Technical Management	5
54-272	Scenic Fabrication and Installation (6 units)	Var.
54-330	Introduction to Stage Management (6 units)	Var.
54-333	Production Personnel Management	6
54-334	Production Resource Management (6 units)	Var.
54-475	Theatre Management	6

NOTE: BCSA Drama students have free units of electives built into their program, any portion of which can be taken in Drama. These additional courses must also be chosen in consultation with the Drama advisor, given the appropriate prerequisites are in place and with the permission of instructors where necessary.

Music Concentration (108 units minimum)

AUDITION AND INTERVIEW REQUIRED FOR ADMISSION TO THE MUSIC COMPOSITION CONCENTRATION OPTION. INTERVIEW REQUIRED FOR ADMISSION TO THE MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Composition, 2) Music Technology

Required Courses for Both Concentration Options (21 units)

57-152	Harmony I	9
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3

Composition Required Courses (66 units)

57-xxx	BXA Studio (4 semesters)	36
57-xxx	Major Ensemble (4 semesters)	24
57-161	Eurhythmics I	3
57-181	Solfege I	3

Choose 21 units from:

57-153	Harmony II	9
57-162	Eurhythmics II	3
57-163	Eurhythmics III	3
57-164	Eurhythmics IV	3
57-182	Solfege II	3
57-183	Solfege III	3
57-184	Solfege IV	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3

Music Technology Required Courses (30 units)

57-101	Introduction to Music Technology	6
57-181	Solfege I	3
57-337	Sound Recording	6
57-347	Electronic and Computer Music	6
57-xxx	Independent Study in Music Technology or Sound Recording	9

Choose 36 units from:

57-153	Harmony II	9
57-182	Solfege II	3
57-283	Music History I	9
57-284	Music History II	9
57-289	Repertoire and Listening for Musicians III *	3
57-290	Repertoire and Listening for Musicians IV *	3
57-338	Sound Editing and Mastering	6
57-438	Multitrack Recording	9

Choose 21 additional Music units in consultation with the Music advisor.

* co-requisite for Music History I and II


IV. Free Electives

(approximately 4-5 courses, 40-50 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.



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Carnegie Institute of Technology

Pradeep Khosla, 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 all 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 the Accreditation Board for Engineering and Technology of ABET; 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 telephone: (410) 347-7700; 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 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 compliment 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 examples of a standard schedule for a first-year engineering student.

Introductory Engineering Elective	12
Restricted Technical Elective	9-12
Differential and Integral Calculus	10
General Education ⁽⁵⁾	9
Computing @ Carnegie Mellon	3

Introductory Engineering Elective	12
Restricted Technical Elective	10
Integration, Differential Equations, Approximation	10
General Education Course ⁽⁵⁾	9

Notes:

1. Each semester every CIT department offers its Introductory Engineering Elective.* Every first year CIT student must select one such course each semester.
* Except 19-101, offered only in spring.

2. Each Introductory Engineering Elective requires a specific Restricted Technical Elective (as a pre or co-requisite) as given below:

Introductory Engineering Course Restricted Technical Elective

Biomedical Engineering 03-121

Chemical Engineering 09-105

Civil & Environmental Engineering 33-106

Electrical & Computer Engineering 15-110 or 15-121

Engineering & Public Policy 33-106

Mechanical Engineering 33-106

Materials Science and Engineering 33-106

3. Restricted Technical Electives include the following courses:

03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry I	10
15-110	Principles of Computing	10
	or 15-121 Introduction to Data Structures (10 units)	
33-106	Physics I for Engineering Students	12

4. All students must complete Physics for Engineering Students I 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.

5. 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

Breadth Requirement 27 units

Humanistic Studies (Cultural Analysis)* 9 units

Cognitions and Institutions* 9 units

* A list of acceptable courses for Humanistic Studies and Cognitions and Institutions is available at www.cit.cmu.edu in the General Education section.

Writing/Expression 9 units

76-101 Interpretation and Argument 9

Depth Sequence in Humanities, Social Science, or Fine Arts 27 units

A sequence of humanities, social science, or fine arts courses which provides depth in a specific area. Usually, 27 units from a single department meet this requirement. However, related courses from different departments may also satisfy this requirement. At least 9 of these units should be beyond the introductory or elementary level and CFA performance courses, if chosen, must also include theory or history of the subject. A depth sequence in language must include at least three nine-unit courses in the same language. Business Administration, Heinz College, and Statistics Department courses may NOT be used to satisfy this requirement. 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 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 (Except for ECE).

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
- Data Storage Systems Technology
- Electronic Materials
- Engineering Design
- Environmental Engineering and Sustainability
- International 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 page 95.

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 page 102 .

Academic Standards

Grading Practices

Undergraduate grading regulations can be found at page 39.

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 the assistant dean of CIT. Students admitted to CIT but excluded from certain departments must also consult with the assistant dean if they wish to transfer into a restricted CIT department. First-year student will be considered 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 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 CIT who wish to transfer into a CIT department beyond the first year will be considered for transfer on a rolling space available/academic performance basis. Procedure for transfer of students from another university 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 QPA or the cumulative QPA (excluding the first year) below 2.0 invokes an academic action.

Probation

The action of probation occurs in the following cases:

- One semester QPA of the first year falls below 1.75.
- 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 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

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. 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 page 39.

Grading procedures for dropped courses can be found at page 39.

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 Control
- Biomedical Engineering
- Colloids, Polymers and Surfaces Technology
- Data Storage Systems Technology
- Electronic Materials
- Engineering Design
- Environmental Engineering
- International Engineering
- Manufacturing Engineering
- Materials Science and Engineering
- Mechanical Behavior of Materials
- Robotics (see "CIT Minors for Non-Engineering Students")

An engineering student may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineer-ing 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 electing 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

Tom Sullivan, Director
Website: http://www.cit.cmu.edu/current_students/services/majors_minors/engineering_minors/audio.html

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 pre-requisite 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.

Course Requirements

The student must have taken the appropriate pre-requisite courses for the listed courses.

Prerequisite Courses, 0/3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Elective Studio (Beginning Piano Class) 3

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.

57-152 Harmony I 6
or 57-149 Basic Harmony I (9 units)
57-173 Survey of Western Music History (co-req 57-188) 9
57-188 Repertoire and Listening for Musicians 1
57-101 Introduction to Music Technology 6
57-337 Sound Recording 6

(choose two of the courses below)

57-347 Electronic and Computer Music 6
57-338 Sound Editing and Mastering 6
57-438 Multitrack Recording 9

Technical Courses, 33 units

Other courses may be taken with the approval of the advisor for engineering minors.

33-114 Physics of Musical Sound 9
18-493 Electroacoustics -Acoustics (pre-reqs 18-220 and 18-290) 12

(choose one of the courses below)

18-491 Fundamentals of Signal Processing (pre-req 18-290) 12
18-551 Digital Communication and Signal Processing Systems Design (pre-req 18-290) 12
18-321 Analysis and Design of Analog Circuits (pre-req 18-220) 12

Units required for minor: 73-79

Note:

18-220 Electronic Devices and Analog Circuits 12
18-290 Signals and Systems 12

Automation and Control Engineering Designated Minor

Bruce Krogh, Director Office: Porter Hall B22

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 Advisors

Chemical Engineering—Larry Biegler
All other CIT departments—Bruce Krogh

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 the 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.

06-362	Chemical Engineering Process Control	9
18-470	Fundamentals of Control	12
24-451	Feedback Control Systems	12
06-708	Advanced Process Dynamics and Control	12
18-771	Linear Systems	12
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
12-741	Data Management	6
18-549	Embedded Systems Design	12
18-649	Distributed Embedded Systems	12
06-423	Unit Operations Laboratory	9
18-474	Embedded Control Systems	12
18-578	Mechatronic Design	12
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
24-351	Dynamics	10
	Independent project	12
xx-xxx	Any course in the list above excluding the basic control course category	
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 Designated Minor

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 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 complete the CIT Minor Request Form and return it to the Associate Head of the Department of Biomedical Engineering.

Requirements for CIT students: five courses, minimum of 48 units

03-121	Modern Biology	
42-101	Introduction to Biomedical Engineering (co-req. or pre-req. 03-121)	
42-202	Physiology (pre-req. 03-121 or permission of instructor)	
xx-xxx	Elective I	

xx-xxx Elective II

Requirements for non-CIT students: six courses, minimum of 60 units

03-121	Modern Biology	
42-101	Introduction to Biomedical Engineering (co-req. or pre-req. 03-121)	
xx-xxx	A second Introductory Engineering Course*	
42-202	Physiology (pre-req. 03-121 or permission of instructor)	
xx-xxx	Elective I#	
xx-xxx	Elective II+	

Electives may be selected from the following:

- 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.
- Any course with a 42-5xx or 42-6xx number.
- 42-203 Biomedical Engineering Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program)**.
- One semester of 42-200 Sophomore Biomedical Engineering Research, 42-300 Junior Biomedical Engineering Research, 42-400 Senior Biomedical Engineering Research or 39-500 CIT Honors Thesis, 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.
- 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, 18-100 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 corequisites 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.

Colloids, Polymers and Surfaces

Annette Jacobson, Director Office: Doherty Hall 3102B

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

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
09-345	Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9

The following four courses are required:

06-609 /09-509 Physical Chemistry of Macromolecules	9
06-607 Physical Chemistry of Colloids and Surfaces	9
06-426 Experimental Colloid Surface Science	9
06-466 Experimental Polymer Science	9

Data Storage Systems Technology Designated Minor

William C. Messner, Director Office: Scaife Hall 312

To complete the minor in Data Storage Systems Technology a student must take at least five courses from the list below. Two of the courses must come from the Required Courses list. Data Storage Systems (18-416), and Introduction to Solid State Physics (33-448). The student must also take at least three of the elective courses. The various fields related to data storage technology are grouped in to five designated concentration areas — Materials and Chemistry; Physics of Data Storage; Dynamics, Control, and Signal Processing; Computer Systems; and Circuit Design. At least two of the elective courses must be in one of the concentration areas. The required introduction courses provide students with the overview needed for them to develop their interests in a manner consistent with the important aspects of the topic. Completing the courses from a concentration will guarantee that a student will have developed sufficient skill and knowledge to be useful for either employment in industry or for further study at the graduate level.

Course Requirements

Required Courses (Two Undergraduate Courses):

18-416 Data Storage Systems	12
18-517 Data Storage Systems Design Project	12
33-448 Introduction to Solid State Physics	9

Elective Courses

Materials and Chemistry Concentration

06-607 Physical Chemistry of Colloids and Surfaces	9
06-609 Physical Chemistry of Macromolecules	9
06-619 Semiconductor Processing Technology	9
06-609 Physical Chemistry of Macromolecules	9
06-714 Surfaces and Adsorption	12
09-348 Inorganic Chemistry	10
27-432 Electronic and Thermal Properties of Metals, Semiconductors and Related Devices	9
27-542 Processing and Properties of Thin Films	9

Physics of Data Storage Concentration

33-225 Quantum Physics and Structure of Matter	9
33-353 Intermediate Optics	12
33-448 Introduction to Solid State Physics	9

A graduate course in quantum physics, magnetism, or optics

Dynamics, Control and Signal Processing Concentration

24-451 Feedback Control Systems	12
24-356 Engineering Vibrations	11
18-396 Signals and Systems	12
18-474 Embedded Control Systems	12

A graduate course in controls, dynamics, or signal processing

Computer Systems Concentration

15-412 Operating System Practicum	Var.
18-348 Embedded Systems Engineering	12
18-349 Embedded Real-Time Systems	12
18-549 Embedded Systems Design	12
18-649 Distributed Embedded Systems	12

A graduate course in computer systems

Circuit Design Concentration

18-525 Integrated Circuit Design Project	12
18-545 Advanced Digital Design Project	12

A graduate course in circuit design

Other Non-Concentration Courses

An independent study project approved by the coordinator of the minor.

Another regular course approved by the coordinator of the minor.

Electronic Materials Designated Minor

David W. Greve, Director Office: Hamerschlag Hall B204

Lisa A. Porter, Co-Director Office: Roberts Engineering Hall 145

Many of the technological changes in recent decades-notably the rise of digital data processing-has 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:

18-100 Introduction to Electrical and Computer Engineering (MSE students)	12
27-201 Structure of Materials (ECE students)	9

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

27-202 Defects in Materials (ECE students only)	9
06-619 Semiconductor Processing Technology	9
27-542 Processing and Properties of Thin Films	9
27-217 Phase Relations and Diagrams (ECE students only)	12
27-533 Principles of Growth and Processing of Semiconductors	6
27-432 Electronic and Thermal Properties of Metals, Semiconductors and Related Devices	9
27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices	9

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27-551	Properties of Ceramics and Glasses	9
27-216	Transport in Materials (ECE students only)	9
33-225	Quantum Physics and Structure of Matter (ECE students only)	9

Group B

18-310	Fundamentals of Semiconductor Devices	12
33-225	Quantum Physics and Structure of Matter (MSE students only)	9
18-412	Field Effect Devices and Technology	12
18-419	Semiconductor Device Applications - Optoelectronics and Nanoelectronics	12
18-410	Physical Sensors, Transducers and Instrumentation	12
18-610	Fundamentals of Modern CMOS Devices	12
18-615	Micro and Nano Systems Fabrication	12
18-617	Memory Devices and Systems	12
18-712	Elements of Photonics for Communication Systems	12
18-416	Data Storage Systems	12
18-715	Physics of Applied Magnetism	12
18-716	Advanced Applied Magnetism	12
18-8XX	An appropriate 800-level course (for example, 18-813, 18-815, 18-819).	

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.

Engineering Design Designated Minor

Susan Finger, Director Office: Porter Hall 123B

Design is a pervasive activity in all engineering disciplines. Insuring quality, timeliness, manufacturability and marketability of engineering designs is a crucial concern in product development. The CIT designated minor in Engineering Design is intended to provide a firm methodological basis for engineering design that will be broadly applicable in numerous specialty domains. The minor is intended primarily for engineering undergraduates who want a broader and more formal foundation in design. The requirements for the minor consist of two interdisciplinary design courses which emphasize design methodology, team work, and real-world problem solving, and three elective courses, at least one should involve CAD and at least one should be outside the student's major.

Faculty Advisors

The designated minor in Engineering Design is administered by the Director of the Institute for Complex Engineered Systems. Students undertaking the designated minor can consult with the program advisor in their major department.

Current faculty advisors are:

- Chemical Engineering—Larry Biegler and Ignacio Grossman
- Civil and Environmental Engineering—Susan Finger and Jim Garrett
- Electrical and Computer Engineering —Daniel P. Siewiorek
- Engineering and Public Policy—Indira Nair
- Mechanical Engineering—Kenji Shimada
- Materials Science and Engineering—Robert Heard

Course Requirements

Required Courses:

Select at least two of the following courses.

39-245	Rapid Prototype Design	9
39-600	Integrated Product Development	12
39-605	Engineering Design Projects	12
39-606	Engineering Design Projects	12
39-647	Special Topics in Design	Var.
39-648	Rapid Design and Prototyping of Computer Science	12

Elective Courses:

Additional elective courses are required, including at least 9 units outside the student's major department and at least one course involving applications of computer-aided design methods. A total of 45 units is required for the minor, including required and elective courses. Courses can be chosen from the list below, the previous list, or by permission of the Minor Advisors.

Undergraduate Elective Courses:

06-421	Chemical Process Systems Design	12
06-606	Computational Methods for Large Scale Process Design & Analysis	9
12-401	Civil & Environmental Engineering Design	15
12-605	Design and Construction	9
12-631	Structural Design	12
18-321	Analysis and Design of Analog Circuits	12
18-322	Analysis and Design of Digital Circuits	12
18-447	Introduction to Computer Architecture	12
18-349	Embedded Real-Time Systems	12
18-341	Logic Design Using Simulation, Synthesis, and Verification Techniques -Aided Digital Design	12
18-474	Embedded Control Systems	12
18-517	Data Storage Systems Design Project	12
18-525	Integrated Circuit Design Project	12
18-545	Advanced Digital Design Project	12
18-447	Introduction to Computer Architecture	12
18-551	Digital Communication and Signal Processing Systems Design	12
24-441	Engineering Design II: Conceptualization and Realization - EPP	12
24-441	Engineering Design II: Conceptualization and Realization - EPP	12
24-683	Design for Manufacture and the Environment	12
27-357	Introduction to Materials Selection	6
27-421	Processing Design	6
39-647	Special Topics in Design	Var.

Graduate Elective Courses

06-720	Advanced Process Systems Engineering	12
12-740	Data Acquisition	6
18-765	Digital System Testing and Testable Design	12
24-781	Engineering Computation Project	Var.
24-784	Decision Tools for Engineering Design	12
27-721	Processing Design	6

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 science, environmental engineering 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 — Jeanne VanBriesen
- Electrical and Computer Engineering — Marija Ilic
- Engineering and Public Policy — Mark Kieler and Edward Rubin
- Mechanical Engineering — Allen Robinson
- Materials Science and Engineering — Paul Salvador and Robert Heard

Course Requirements for Environmental Engineering and Sustainability Minor

The requirements include two core courses, three technical electives, and two policy electives.

A1. Core Courses in Sustainability (12 units)

Select one set of two mini courses from:

19-622 /12-712 Introduction to Sustainable Engineering	6
19-623 /12-713 Industrial Ecology and Sustainable Engineering Design	6

or

19-614 /12-714 Environmental Life Cycle Assessment and Green Design	6
19-616 Case Studies in Sustainability Engineering	6

A2. Core Courses in Environmental Engineering (9 units)

Select one NOT in your home major department from:

12-351 Environmental Engineering	9
24-424 /19-424 Energy and the Environment	9
12-651 Air Quality Engineering	9
24-425 Combustion and Air Pollution Control	9
12-702 Fundamentals of Water Quality Engineering	12
06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods	9

B. Technical Electives in Environmental Engineering and Sustainability (27 units)

Select three from the following list

03-121 Modern Biology	9
09-106 Modern Chemistry II	10
09-510 Introduction to Green Chemistry	9
06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods	9
12-351 Environmental Engineering	9
12-651 Air Quality Engineering	9
12-702 Fundamentals of Water Quality Engineering	12
12-657 Water Resources Engineering	9
12-658 Hydraulic Structures	9
24-424 Energy and the Environment	9
24-425 Combustion and Air Pollution Control	9
19-622 /12-712 Introduction to Sustainable Engineering *	6
19-623 /12-713 Industrial Ecology and Sustainable Engineering Design *	6
19-614 /12-714 Environmental Life Cycle Assessment and Green Design *	6
19-616 Case Studies in Sustainability Engineering *	6
19-650 Climate and Energy: Science, Economics and Public Policy	9
27-322 Processing of Metals **	9
27-323 Powder Processing of Materials **	9
27-421 Processing Design *	6
27-367 Selection and Performance of Materials *	6
27-594 Electrochemical Degradation of Materials	9
48-315 Environment I: Climate & Energy	9
48-415 Advanced Building Systems	6
48-596 LEED Buildings and Green Design	6
48-569 GIS/CAFM	9

* 6 units; must be combined with 3 additional units
 ** Students may take either 27-322 Processing of Metals, or 27-323 Powder Processing of Materials, but not both, as technical electives in this category.

C. Policy Electives (18 units)

Select two from the following list of humanities/social science-oriented courses:

19-448 Science, Technology & Ethics	9
48-576 Mapping Urbanism	9
73-148 Environmental Economics	9
73-357 Regulation: Theory and Policy	9
73-358 Economics of the Environment and Natural Resources	9
73-359 Benefit-Cost Analysis	9
76-319 Environmental Rhetoric	9
79-244 Women in American History	9
79-326 History of German Cinema History of Modern Germany through its Cinema	9
79-383 Epidemic Disease and Public Health	9
79-343 History of American Urban Life	9
79-345 The Roots of Rock and Roll, 1870-1970	9

79-346 American Political Humor from Mark Twain to the Daily Show	9
79-398 /88-346 Documenting the 1967 Arab-Israeli War	9
79-211 Unity of Islam and Diversities in the Muslim World	9
79-212 China and Its Neighbors: Minorities, Conquerors and Tribute Bearers	9
80-242 Conflict and Dispute Resolution	9
80-244 Environmental Ethics	9
88-220 Policy Analysis I	9
88-221 Policy Analysis II	9
88-223 Decision Analysis and Decision Support Systems	9
80-344 Management, Environment, and Ethics	9
90-747 Cost Benefit Analysis	6
90-758 Ethics & Public Policy in a Global Society	6
90-765 Cities, Technology and the Environment	6
90-789 Sustainable Community Development	12
90-798 Environmental Policy & Planning	12

NOTES:

1. The 48-xxx courses may not be acceptable as technical electives by some CIT engineering departments (At most one of these courses can be used as a Type B course and one as a Type C course.)
2. Course 12-351 Environmental Engineering can be counted toward completion of the environmental engineering and sustainability course requirements for non-CEE students only.
3. Courses cannot be double-counted for lists A and B.
4. Courses used to fulfill the basic science requirement for CIT cannot be double-counted for list B requirements. Courses required within a student's CIT major can be double-counted for list B requirements.
5. Students may take up to two list B courses in their home department. One list B course must be from outside their home department. EPP double-majors should NOT consider EPP their home department.
6. Other H&SS courses with similar or related content may be substituted for Type C courses with permission of the student's departmental advisor and the Director.
7. A group of three environmental policy courses MAY be counted as fulfilling the H&SS depth requirement required of all CIT students.
8. A list of relevant courses for Type B and C in each semester is provided at the Environmental Engineering and Sustainability Minor website: <http://www.ce.cmu.edu/~dzombak/envminor.html>

International Engineering Studies Designated Minor

Kurt Larsen, Director
 Office: Scaife Hall 110

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.

Requirements for the minor include:

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

or approved equivalent.

Regional Specialization (1 course)

Complete one course in non-US History, international politics, or literature in a single region of the world.

Ethics (1 course)

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Any ethics course that provides some exposure to international ethics issues such as:

70-332	Business, Society and Ethics	9
80-243	Business Ethics	6
80-244	Environmental Ethics	9

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 or participate in an approved short-term global experience program.

Manufacturing Engineering Designated Minor

Bruce H. Krogh, Director Office: Porter Hall B22

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 — Arthur Westerberg
- Civil and Environmental Engineering — Susan Finger
- Electrical and Computer Engineering — Bruce H. Krogh
- Engineering and Public Policy — Mark Kieler
- Materials Science and Engineering — Anthony D. Rollett
- Mechanical Engineering — Kenji Shimada

Course Requirements

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 Manufacturing Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

Two Core Courses:

24-341	Manufacturing Sciences	9
27-357	Introduction to Materials Selection (non MSE Majors)	6

or

27-401 & 27-402	MSE Capstone Course I-II (MSE Majors)	24
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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
18-349	Embedded Real-Time Systems -time Systems	12
18-474	Embedded Control Systems	12
18-549	Embedded Systems Design	12
18-649	Distributed Embedded Systems	12

Design, Materials and Processes

06-362	Chemical Engineering Process Control	9
24-683	Design for Manufacture and the Environment	12
27-322	Processing of Metals	9
27-323	Powder Processing of Materials	9
27-421	Processing Design	6
27-592	Solidification Processing	9
27-322	Processing of Metals	9
27-421	Processing Design	6
27-442	Deformation Processing	9
27-533	Principles of Growth and Processing of Semiconductors	6
39-245	Rapid Prototype Design	9

Production Management and Control

12-411	Engineering Economics	6
12-611	Project Management Construction	9
36-220	Engineering Statistics and Quality Control	9
70-430	International Management	9
70-371	Production/Operations Management	9
70-471	Logistics and Supply Chain Management	9

Language:

Because of the international nature of manufacturing enterprises, students are strongly encouraged to complete one of the following:

82-221 & 82-222	Intermediate German I-II	18
82-271 & 82-272	Intermediate Japanese I-II	24

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)

27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-217	Phase Relations and Diagrams	12

* The laboratories with these courses are not required as core but will be counted as elective units if desired. If not desired, the minor options for these courses are 27-211 (6 units), 27-212 (6 units) and 27-227 (9 units).

Elective Courses (24 units minimum)

The student must select a minimum of 24 units from the following list:

27-100	Engineering the Materials of the Future	12
27-301	Microstructure and Properties I	9
27-302	Microstructure and Properties II	9
27-311	Polymeric Biomaterials	9
27-312	Metallic and Ceramic Biomaterials	9
27-322	Processing of Metals	9
27-323	Powder Processing of Materials	9
27-357	Introduction to Materials Selection	6
27-433	Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices	9
27-582	Phase Transformations in Solids	9
27-421	Processing Design	6
27-432	Electronic and Thermal Properties of Metals, Semiconductors and Related Devices	9
27-512	Diffraction Methods in Materials Science	9
27-591	Mechanical Behavior of Materials	9
27-560	Physical Chemistry of Metallurgical Reactions	9
27-454	Supervised Reading	Var.
27-530	Advanced Physical Metallurgy	9
27-533	Principles of Growth and Processing of Semiconductors	6
27-565	Nanostructured Materials	9
27-542	Processing and Properties of Thin Films	9
27-551	Properties of Ceramics and Glasses	9
27-566	Special Topics in MSE	9
27-592	Solidification Processing	9
42-444	Medical Devices	9

Group A: Materials Science Courses

Each student must take one course from this list of Materials Science courses:

27-202	Defects in Materials ⁽¹⁾	9
27-324	Introduction to Polymer Science and Engineering	9
27-357	Introduction to Materials Selection ⁽²⁾	6
27-551	Properties of Ceramics and Glasses	9
42-511	Biomaterials	9

Group B: Solid Mechanics Courses

Each student must take two of the following Solid Mechanics courses:

12-231	Solid Mechanics	9
	or24-262 Stress Analysis (12 units)	
12-635	Structural Analysis	9
	or24-351 Dynamics (10 units)	
24-751	Introduction to Solid Mechanics I	12

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.

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.

Mechanical Behavior of Materials Designated Minor

Warren M. Garrison, Jr., Director
Office: Wean Hall 3303

An understanding of mechanical behavior is important to both the development of new materials and the selection of appropriate materials for many applications. The mechanical behavior of materials is best investigated and understood by integrating solid mechanics with the microstructural basis of flow and fracture. The purpose of this minor is to allow a formal basis for students to pursue an integrated approach to the mechanical behavior of materials. Although this minor is open to all CIT students, only students in the departments of Civil Engineering, Materials Science and Engineering, and Mechanical Engineering can take advantage of the double counting permitted for some courses in their department majors. Students in other departments may have difficulty in fulfilling the requirements in four years.

Faculty Advisors

- Chemical Engineering — Paul Sides
- Electrical and Computer Engineering — David W. Greve
- Mechanical Engineering — Paul S. Steif
- Materials Science and Engineering — Warren M. Garrison, Jr.

Course Requirements

The minor requires six courses: three core courses, two solid mechanics courses, and one materials science course. In satisfying these course requirements, each student must take three out-of-department courses. Each student is required to complete three core courses:

Core Courses:

27-201	Structure of Materials	9
12-212	Statics	9
	or24-261 Statics (10 units)	
27-591	Mechanical Behavior of Materials	9
	or27-791 Mechanical Behavior of Materials (12 units)	

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 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 complete the CIT Minor Request Form and return it to the Associate Head of the Department of Biomedical Engineering.

Requirements for non-CIT students: six courses, minimum of 60 units

03-121	Modern Biology	9
42-101	Introduction to Biomedical Engineering	12
xx-xxx	A second Introductory Engineering Course *	
42-202	Physiology (pre-req. 03-121 or permission of instructor)	9
xx-xxx	Elective I (#)	
xx-xxx	Elective II (+)	

Electives may be selected from the following:

- 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.
- Any course with a 42-5xx or 42-6xx number.
- 42-203 Biomedical Engineering Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program)**.
- One semester of 42-200 Sophomore Biomedical Engineering Research, 42-300 Junior Biomedical Engineering Research, 42-400 Senior Biomedical Engineering Research or 39-500 CIT Honors Thesis, 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.
- 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, 18-100 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 corequisites 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 QPA of 2.00 in these five courses.

Double counting of core courses in student's primary major is not permitted.

Requirements

- 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

- Three courses of at least 9 units each from one or more CIT departments
- NOTE:** The following courses may NOT be included as part of the Minor in Engineering Studies. Please refer to the CIT website for a complete listing of unacceptable courses www.cit.cmu.edu.

18-200 /202	Emerging Trends in Electrical and Computer Engineering	1
39-200	Business for Engineers	9
24-201	Engineering Graphics	9
42-202	Physiology	9
18-202	Mathematical Foundations of Electrical Engineering	12
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	Special Topics	3
19-681	Managerial and Engineering Economics	12
19-682	The Strategy and Management of Technological Innovation	12

19-687	Special Topics: Principles and Practices of R&D Management	6
19-688	Special Topics: 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.

Although a student generally can complete the minor in Engineering Studies without increasing the number of required units for graduation, early planning in selecting courses is important. Students interested in this minor are encouraged to seek advice in their own home department or college and in the CIT Office of Undergraduate Studies, Scaife Hall 110.

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 (12 units)	
73-100	Principles of Economics	9
88-223	Decision Analysis and Decision Support Systems	9
	or 88-302 Behavioral Decision Making (9 units)	
	or 19-426 Environmental Decision Making (9 units)	
xx-xxx	EPP Technical Electives - 2 courses	18

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 on the EPP Undergraduate Program website.

Students interested in the T&P minor should contact the Department of Engineering and Public Policy early in their course of study.

Robotics Minor

(for engineering and non-engineering Students)

Howie Choset, Director Office: Scaife Hall 315

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.

Following is the list of courses that must be completed for the Minor in Robotics:

Overview

16-311	Introduction to Robotics	12
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One of the following courses:

24-451	Feedback Control Systems	12
18-370	Fundamentals of Control	12
06-362	Chemical Engineering Process Control	9
16-299	Introduction to Feedback Control Systems (Computer Science)	12

Manipulation, Dynamics, Mechanisms

One of the following courses:

15-384	Robotic Manipulation	12
24-353	Intermediate Dynamics	9
24-355	Kinematics and Dynamics of Mechanisms	9

Electives

Two of the following courses:

15-385	Computer Vision	9
60-422	Advanced ETB: Robotic Art Studio	10
16-362 /862	Mobile Robot Programming Laboratory	12
24-7xx	Mechanical Engineering Course	
15-381	Artificial Intelligence: Representation and Problem Solving	9
85-213	Human Information Processing and Artificial Intelligence	9

One Independent study course

An upper level RI course

Department of Biomedical Engineering

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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, physiology, and clinical medicine. Biomedical engineering (BME) education at Carnegie Mellon reflects the belief that a top biomedical engineer must be deeply trained in both a 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 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)

42-101	Introduction to Biomedical Engineering	12
	Fall and Spring	
42-201	Professional Issues in Biomedical Engineering	3
	Fall and Spring	
42-202	Physiology	9
	Fall and Spring	
42-203	/03-206 Biomedical Engineering Laboratory	9
	Fall and Spring	
03-121	Modern Biology	9
	Fall and Spring	
42-401	Foundation of BME Design *	3
	Fall	
42-402	BME Design Project	9
	Spring	

Also known as 03-206 for Health Professions Program students.

*42-401 serves as the precursor/pre-requisite for 42-402 Biomedical Engineering Design Project.

Tracks (Completion of one track is required)

- Biomaterials and Tissue Engineering (BMTE)
- Biomechanics (BMEC)
- Biomedical Signal and Image Processing (BSIP)
- Cellular and Molecular Biotechnology (CMBT)
- General Biomedical Engineering (GBME)
- Self-Designed Biomedical Engineering (SBME)

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, students in the BMTE Track must take the following:

BMTE Gateway Course (required)

03-232 Biochemistry I - Spring (MSE majors may substitute 03-231) 9

BMTE Capstone Course (required)

42-419 Biomaterial/Host Interactions - Fall 12

BMTE Electives (choose 2)

03-240 Cell Biology - Spring 9
 09-217 Organic Chemistry I - Fall 9
 09-218 Organic Chemistry II - Spring 9
 42-311 /27-311 Polymeric Biomaterials -Spring 9
 24-415 Microfluidics - Intermittent 9
 42-509 Special Topics - Spring, every other year 9
 42-511 Biomaterials - Spring, intermittent 9
 42-620 Engineering Molecular Cell Biology - Fall 12
 42-624 Biological Transport - Spring, intermittent 9
 42-660 Surgery for Engineers ** - Fall/Spring 9
 42-x00 BME Research

** The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Thesis) 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-x00 BME Research OR 39-500 CIT Honors Research (with BME supervision) OR 42-660 Surgery for Engineers as a track elective. Students MAY NOT count both research and Surgery for Engineers as track electives.

BMTE gateway course 03-232 Biochemistry and track elective 09-217 Organic Chemistry I satisfy Chemical Engineering course requirements.

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 page on the BME 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 quantitative 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, students in the BMEC Track must take the following:

BMEC Gateway Course (required)

42-341 Introduction to Biomechanics - Fall 9

BMEC Electives (choose 3)

33-441 /03-439 Introduction to BioPhysics - Fall 10
 42-441 Cardiovascular Biomechanics - Spring, every other year 9
 42-444 Medical Devices - Fall 9
 24-415 Microfluidics - Spring, intermittent 9
 42-447 Rehabilitation Engineering - Fall 9
 42-624 Biological Transport - Spring, intermittent 9
 42-640 /24-658 Computational Bio-Modeling and Visualization - Spring 12
 42-641 /24-676 Bio Inspired Robotics - Fall 12
 42-645 /24-655 Cellular Biomechanics -Spring, every other year 9
 42-646 /24-657 Molecular Biomechanics - Spring, every other year 9
 42-660 Surgery for Engineers ** - Fall/Spring 9
 42-x00 BME Research **

** The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Thesis) 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-x00 BME Research OR 39-500 CIT Honors Research (with BME supervision) OR 42-660 Surgery for Engineers as a track elective. Students MAY NOT count both research and Surgery for Engineers as track electives.

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 BMEC page on the BME 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, students in the BSIP Track must take the following:

BSIP Gateway Course (required)

18-290 Signals and Systems - Fall/Spring 12

BSIP Track Electives (choose 3)

03-534 Biological Imaging and Fluorescence Spectroscopy - Spring 9
 15-386 Neural Computation - Spring 9
 18-491 Fundamentals of Signal Processing - Fall 12
 42-334 /03-310 Introduction to Computational Biology - Spring 12
 42-426 Biosensors and BioMEMS - Spring, every other year 9
 42-431 /18-496 Introduction to Biomedical Imaging and Image Analysis - Fall 12
 42-590 Special Topics in Signal Processing: - Fall 12

42-640 /24-658 Computational Bio-Modeling and Visualization - Spring	12
42-660 Surgery for Engineers ** - Fall/Spring	9
42-735 Medical Image Analysis -Spring	12
42-x00 BME Research **	

** The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Thesis) 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-x00 BME Research OR 39-500 CIT Honors Research (with BME supervision) OR 42-660 Surgery for Engineers as a track elective. Students MAY NOT count both research and Surgery for Engineers as track electives.

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 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 bio/pharmaceutical manufacture, pharmacology, medical diagnostics, biosensors, drug delivery devices, and biological aspects of environmental engineering.

In addition to the general BME requirements, students in the CMBT Track must take the following:

CMBT Gateway Course (required)

42-321 Cellular and Molecular Biotechnology - Fall	9
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CMBT Track Electives (choose 3)

03-232 Biochemistry I Spring	9
03-240 Cell Biology Spring	9
42-426 Biosensors and BioMEMS Spring, every other year	9
24-415 Microfluidics Spring, every other year	9
42-509 Special Topics Spring	9
42-620 Engineering Molecular Cell Biology Fall	12
42-622 /06-622 Bioprocess Design Spring, intermittent	9
42-624 Biological Transport Spring, intermittent	9
42-645 /24-655 Cellular Biomechanics Spring, every other year	9
42-646 /24-657 Molecular Biomechanics Spring, every other year	9
42-660 Surgery for Engineers ** Fall/Spring	9

** The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Thesis) 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-x00 BME Research OR 39-500 CIT

Honors Research (with BME supervision) OR 42-660 Surgery for Engineers as a track elective. Students MAY NOT count both research and Surgery for Engineers as track electives.

03-232 Biochemistry satisfies Chemical Engineering course requirements.

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 BMEC 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, students in the GBME track must take one gateway course (03-232 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.**

** The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Thesis) 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-x00 BME Research OR 39-500 CIT Honors Research (with BME supervision) 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

- 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.
- 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.).
- 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.
- Students may count EITHER Surgery for Engineers 42-660 (9 units) or 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 CIT Honors Thesis) 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 GBME track if he/she completes one of the regular track gateway courses plus either three 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).

Course Requirements for the Minor

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 Designated Minor should complete the CIT Minor Request Form and return it to the Associate Head of the Department of Biomedical Engineering.

Requirements for CIT students: five courses, minimum of 48 units

03-121	Modern Biology	9
42-101	Introduction to Biomedical Engineering (co-req. or pre-req. 03-121)	12
42-202	Physiology (pre-req. 03-121 or permission of instructor)	9
xx-xxx	Elective I	
xx-xxx	Elective II	

Requirements for non-CIT students: six courses, minimum of 60 units

03-121	Modern Biology	9
42-101	Introduction to Biomedical Engineering (co-req. or pre-req. 03-121)	12
xx-xxx	A second Introductory Engineering Course *	
42-202	Physiology (pre-req. 03-121 or permission of instructor)	9
xx-xxx	Elective I ^(#)	
xx-xxx	Elective II ⁽⁺⁾	

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 42-5xx 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 Biomedical Engineering Research, 42-300 Junior Biomedical Engineering Research, 42-400 Senior Biomedical Engineering Research or 39-500 CIT Honors Thesis,

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.

Notes:

* Select either 06-100 Introduction to Chemical Engineering, 12-100 Introduction to Civil and Environmental Engineering, 18-100 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 corequisites 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.

Full-Time Faculty

- ANTAKI, JAMES F. , Professor of Biomedical Engineering – Ph.D, University of Pittsburgh, 1991; .
- ARMITAGE, BRUCE A. , Professor of Chemistry, Biological Sciences, and Biomedical Engineering – Ph.D., University of Arizona, 1993; .
- BETTINGER, CHRISTOPHER J. , Assistant Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., Massachusetts Institute of Technology, 2008; .
- BRUCHEZ, MARCEL P. , Associate Research Professor of Chemistry and Biomedical Engineering – Ph.D., University of California, Berkeley, 1998; .
- CAMPBELL, PHIL G. , – Research Professor, Institute of Complex Engineering Systems, Biomedical Engineering, Biological Sciences, Materials Science & Engineering , Ph.D.; Carnegie Mellon, The Pennsylvania State University, 1985–.
- CHOSSET, HOWIE, Associate Professor, Robotics Institute, Biomedical Engineering, and Electrical & Computer Engineering – Ph.D., California Institute of Technology , 1996; .
- CROWLEY, JUSTIN C. , Assistant Professor of Biological Sciences and Biomedical Engineering – Ph.D., Duke University, 2000; .
- DAHL, KRIS N. , Assistant 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; .
- FEINBERG, ADAM W., Assistant Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., University of Florida, 2004; .
- FINOL, ENDER , Associate Research Professor, Institute for Complex Engineering Systems, Biomedical Engineering and Mechanical Engineering – Ph.D., Carnegie Mellon University, 2002; .
- 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; .
- KOVACEVIC, JELENA , Professor of Biomedical Engineering and Electrical & Computer Engineering – Ph.D., Columbia University, 1991; .
- LEDUC, PHILIP R., Associate 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; .

MCHENRY , 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; .

PEKKAN, KEREM, Assistant Professor of Biomedical Engineering and Mechanical Engineering – Ph.D., Middle East Technical University, 2000; .

PRZYBYCIEN, 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; .

SCHNEIDER, JAMES W., – Professor of Chemical Engineering and Biomedical Engineering, Ph.D.; Carnegie Mellon, University of Minnesota, 1998–.

SHIMADA, KENJI, Professor, Mechanical Engineering, Biomedical Engineering, Robotics Institute, and Institute of Complex Engineering Systems – Ph.D., Massachusetts Institute of Technology, 1993; .

SITTI , METIN, Associate 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. , Assistant 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., Teaching Associate 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 Monterey 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 BS in Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone: (410)347-7700, www.abet.org.

First Year

Fall		Units
21-120	Differential and Integral Calculus	10
76-xxx	Designated Writing/Expression Course	9
99-101	Computing @ Carnegie Mellon	3
06-100	Introduction to Chemical Engineering	12
09-105	Introduction to Modern Chemistry I	10
		<hr/> 44

110 Department of Chemical Engineering

Spring		Units
21-122	Integration, Differential Equations and Approximation	10
xx-xxx	Introductory Engineering Elective (other than ChE)	12
33-106	Physics I for Engineering Students	12
xx-xxx	General Education Course	9
		43

Second Year

Fall		Units
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
06-222	Sophomore Chemical Engineering Seminar	1
09-106	Modern Chemistry II	10
xx-xxx	Computer Sci./Physics II *	10-12
xx-xxx	General Education Course	9
		48-50

Spring		Units
06-261	Fluid Mechanics	9
06-262	Mathematical Methods of Chemical Engineering	12
09-221	Laboratory I: Introduction to Chemical Analysis	12
xx-xxx	Physics II/Computer Sci. *	10-12
xx-xxx	General Education Course	9
		52-54

* Computer Science/Physics II: Students should complete 15-110 Principles of Computing or 15-121 Introduction to Data Structures as well as 33-107 Physics II for Engineering Students by the end of the Sophomore year. The recommended sequence is 33-106 /33-107 for engineering students, however, 33-111/ 33-112 or 33-131 /33-132 will also meet the CIT Physics requirement.

For those students who have not taken 06-100 as one of the two Introductory Engineering Electives, 06-100 should be taken in the Fall Semester of the Sophomore year. The General Education Course normally taken during that semester may be postponed until the Junior year. These students should consult with their faculty advisors as soon as possible.

At the end of the Sophomore year, a student should have completed the following required basic science and computer science courses:

09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
09-221	Laboratory I: Introduction to Chemical Analysis	12
15-110	Principles of Computing	10
	or 15-121 Introduction to Data Structures (10 units)	
33-106	Physics I for Engineering Students	12
33-107	Physics II for Engineering Students	12
99-10x	Computing @ Carnegie Mellon	3

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior Chemical Engineering Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
	or 09-219 Modern Organic Chemistry (10 units)	
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		50

Spring		Units
06-361	Unit Operations of Chemical Engineering	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Process Laboratory	6
03-232	Biochemistry I **	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
06-421	Chemical Process Systems Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
06-462	Optimization Modeling and Algorithms	6
06-463	Chemical Product Design	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

**Students pursuing a Chemical Engineering/Engineering and Public Policy double major are waived from taking the Biochemistry Elective. They will take 36-220.

Notes :

- 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).
- Minimum number of units required for graduation: 386.
- Overloads are permitted only for students maintaining a QPA of 3.0 or better during the preceding semester.
- 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.
- 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.
- 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 Engineers 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
06-426	Experimental Colloid Surface Science	9
06-466	Experimental Polymer Science	9
06-607	Physical Chemistry of Colloids and Surfaces	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 (MChE)

This degree offers qualified undergraduate students the opportunity to obtain a Masters degree in Chemical Engineering in less than one academic 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, – Ph.D., Harvard University; Carnegie Mellon, 2003–.

LORENZ T. BIEGLER, Bayer Professor of Chemical Engineering – Ph.D., University of Wisconsin; Carnegie Mellon, 1981–.

KRIS N. DAHL, Assistant 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–.

MOHAMMAD F. ISLAM, Assistant Professor of Chemical Engineering – Ph.D., Lehigh University; Carnegie Mellon, 2005–.

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, – PhD, California Institute of Technology; Carnegie Mellon, 2010–.

JOHN KITCHIN, Assistant Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2006–.

EDMOND I. KO, Adjunct Professor of Chemical Engineering – Ph.D., Stanford University; Carnegie Mellon, 1980–.

KUN LI, Professor Emeritus of Chemical Engineering – Sc.D., Carnegie Mellon University; Carnegie Mellon, 1962–.

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–.

TODD M. PRZYBYCIEN, Professor Of Chemical Engineering And Biomedical Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 1998–.

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–.

HERBERT L. TOOR, Emeritus Professor of Chemical Engineering – Ph.D., Northwestern University; Carnegie Mellon, 1953–.

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
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 virtual 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 attendant 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.

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 design or analysis. 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 green design. Historically, 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 and Public Policy are described in the curriculum specified by those departments. Other double-major programs selected by recent graduates include computer science, economics, mathematics, business, architecture, history, and foreign languages. Each student should have well defined objectives in selecting courses leading to a specialty, a minor or a double major.

Educational Objectives

The objectives of the Bachelor of Science in Civil Engineering curriculum are to develop:

- Graduates effectively tackle both routine and cutting-edge professional challenges at the intersections of the built, natural, and information environments;
- Graduates are successful and recognized as innovative and adaptive leaders in academic research, government service and private sector activity, over a wide range of engineering and non engineering professions, both in the U.S. and internationally; and
- Graduates use skills learned during their undergraduate education as leaders of their professional and social communities - problem finding/modeling/solving; critical and systems-level thinking; ethical reasoning; written, oral and graphical communications; collaborative team-building and problem solving; and self- and life-long learning.

The Civil Engineering curriculum is intended to allow ample opportunity for students to pursue areas of personal interest. The opportunity for self-exploration requires careful advising to gain meaningful educational experiences. We believe that design and team working experiences should occur at regular intervals in the curriculum, and that graduates should have appropriate "hands on" experience in laboratories and projects. Students are encouraged to participate in research projects and to pursue study or work abroad.

The Civil Engineering program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone: (410) 347-7700.

By the end of the B.S. program, students should have achieved the following ABET outcomes:

- A. an ability to apply knowledge of mathematics (specifically, differential equations and probability and statistics) science (specifically, calculus-based physics and general chemistry) and engineering to practice and problem solving
- B. an ability to design and conduct experiments as well as to analyze critically and interpret data in environmental engineering, solid mechanics, fluid mechanics and soil mechanics
- 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 multi-disciplinary teams
- E. an ability to identify, formulate and solve civil engineering problems
- F. an understanding of professional and ethical responsibility
- G. an ability to communicate effectively in graphics, speech and words
- H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
- I. recognition of the need for and an ability to engage in lifelong learning
- J. knowledge of contemporary issues relevant to engineering practice
- K. an ability to use the techniques, skills and modern engineering tools necessary for civil engineering practice
- L. an ability to apply knowledge in environmental engineering
- M. an ability to apply knowledge in structural engineering
- N. an ability to apply knowledge in construction and management
- O. an ability to apply knowledge computing in civil engineering
- P. an ability to explain basic concepts in management, business, public policy, leadership, and the importance of professional licensure

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 Experimental Chemistry	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.

Freshman Year

Fall		Units
12-100	Introduction to Civil and Environmental Engineering	12
21-120	Differential and Integral Calculus	10
33-106	Physics I for Engineering Students	12
99-10x	Computing @ Carnegie Mellon	3
xx-xxx	H&SS Elective	9
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		46

Spring		Units
xx-xxx	Introduction to Engineering (other than CEE)	12
21-122	Integration, Differential Equations and Approximation	10
33-107	Physics II for Engineering Students	12
xx-xxx	H&SS Elective	9
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Sophomore Year

Fall		Units
12-212	Statics	9
21-259	Calculus in Three Dimensions	9
09-101	Introduction to Experimental Chemistry	3
15-110	Principles of Computing	10
09-105	Introduction to Modern Chemistry I	10
xx-xxx	H&SS Elective	9
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Spring		Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
12-271	Introduction to Computer Application in Civil & Environmental Engineering	9
21-260	Differential Equations	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9
		<hr/>
		48

* Notes: If a student takes an Introduction to Engineering course which has a co-requisite other than Physics II, the co-requisite (either 15-110 or 09-105 and 09-101) should be taken in the freshman year while Physics II will fill the respective slot in the sophomore year.

Since CIT freshmen are not required to select a major, the above curriculum is based on the assumption that a potential CEE student is likely to select 12-100 as one of the two Introduction to Engineering courses in the freshman year. Otherwise, incoming sophomores should take 12-100 in the fall in lieu of Modern Chemistry or the H&SS elective.

Junior Year

Fall		Units
12-301	Civil Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics Laboratory	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9
		<hr/>
		51

Spring		Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Introduction to Materials Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9
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		48

Senior Year

Fall		Units
12-401	Civil & Environmental Engineering Design	15
12-411	Engineering Economics	6
12-4xx	Engineering course	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9
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		45

Spring		Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9
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		45

Minimum number of units required for degree: 379

Notes on Electives

1. One elective must be in the basic sciences, from the following list:

03-121	Modern Biology	9
12-201	Geology	9

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

		Units
12-600	AutoCAD	3
12-605	Design and Construction	9
12-631	Structural Design	12
12-636	Geotechnical Engineering	9
12-657	Water Resources Engineering	9
15-211	Fundamental Data Structures and Algorithms	12
18-100	Introduction to Electrical and Computer Engineering	12
21-228	Discrete Mathematics	9
21-241	Matrix Algebra	9
		<hr/>
		84

Environmental Engineering

	Units
12-657 Water Resources Engineering	9
12-636 Geotechnical Engineering	9
12-658 Hydraulic Structures	9
12-651 Air Quality Engineering	9
06-221 Thermodynamics	9
06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods	9
09-510 Introduction to Green Chemistry	9
24-424 Energy and the Environment	9
48-596 LEED Buildings and Green Design	6
	78

Structures, Mechanics and Geotechnical Engineering

	Units
12-600 AutoCAD	3
12-605 Design and Construction	9
12-635 Structural Analysis	9
24-370 Engineering Design I: Methods and Skills	12
12-631 Structural Design	12
12-636 Geotechnical Engineering	9
21-228 Discrete Mathematics	9
21-241 Matrix Algebra	9
24-262 Stress Analysis	12
24-356 Engineering Vibrations	11
	95

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.

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 internships would ordinarily graduate after an additional semester 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 tenth semester of study, students should 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, Associate Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 2001–.

BURCU AKINCI, Associate Professor of Civil and Environmental Engineering – Ph.D., Stanford University; Carnegie Mellon, 2000–.

JACOBO BIELAK, Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; 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; Carnegie Mellon, 1977–.

JARED L. COHON, President and Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; 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. Professor of Civil and Environmental Engineering; Associate Dean, Carnegie Institute of Technology – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

SUSAN FINGER, Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

JAMES H. GARRETT, JR., Professor and Head, Civil and Environmental Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990–.

KELVIN GREGORY, Assistant Professor of Civil and Environmental Engineering – Ph.D., University of Iowa; Carnegie Mellon, 2006–.

CHRIS T. HENDRICKSON, Duquesne Light Company Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978–.

GREGORY LOWRY, Associate Professor of Civil and Environmental Engineering . – Ph.D., University of Illinois; Carnegie Mellon, 2002–.

H. SCOTT MATTHEWS, Associate Professor of Civil and Environmental Engineering . – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001–.

CRAIG MALONEY, Assistant 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; Carnegie Mellon, 1972–.

MITCHELL J. SMALL, Professor of Civil and Environmental Engineering and Engineering and Public Policy – Ph.D., University of Michigan; Carnegie Mellon, 1982–.

LUCIO SOIBELMAN, Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2004–.

JEANNE VANBRIESEN, Professor of Civil and Environmental Engineering – Ph.D., Northwestern University; 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 ABET-accredited degree program structured to provide students with the smallest set of constraints consistent with a rich and comprehensive view of the profession. Students are encouraged and stimulated to explore multiple areas of theory and application. The Faculty of Electrical and Computer Engineering 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 on multi-disciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
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.

Educational Objectives

A. What they know

Our graduates will solve problems based on:

- Fundamentals—knowledge of ECE fundamentals;
- Breadth—understanding the breadth of areas in ECE;
- Depth—substantive command of some specific area(s) of ECE.

B. How they think

Creatively—our graduates will develop creative solutions to problems in current and emerging applications.

Holistically—our graduates will define problems and formulate solutions from a systems perspective.

Strategically—our graduates will anticipate and plan for change and innovation, and engage in lifelong learning.

C. What they do

Initiate—our graduates will stand out for their resourcefulness, ingenuity, and ability to find innovative solutions to problems.

Collaborate—our graduates will work successfully in multidisciplinary teams.

Lead—our graduates will contribute to sustained improvement and development in their organizations, their profession, and society at large.

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 (141 units), the B.S. in Electrical and Computer Engineering requires Effective Programming in C and Unix (9 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 (60 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, 18-243 Introduction to Computer Systems, and 18-290 Signals and Systems), and two math co-requisites. 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 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.; Signals and Systems: Digital Signal Processing, Communication Systems, Control Systems, etc.; Circuits: Analog and Digital Circuits, Integrated Circuit Design, etc.; Computer Hardware: Logic Design, Computer Architecture, Networks, etc.; and Computer Software: Programming, Data Structures, Compilers, Operating Systems, etc.

For the ECE Depth Requirement, one course must be taken that has one of the ECE Breadth courses as a prerequisite. For Coverage any additional ECE course(s) can be taken or approved Computer

Science course (see the ECE website for the list of approved Computer Science courses) totaling at least 12 units. Finally, all students are required to take a Capstone Design course. In the Capstone Design courses, numbered 18-5XX, students participate in a semester-long design projects with teams of other students. Students learn project management skills, make oral presentations, write reports, and discuss the broader social and ethical dimensions of ECE. Current Capstone Design courses are listed on the Web.

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, please refer to the ECE World Wide Web Home Page: <http://www.ece.cmu.edu/>

University Requirement

99-10x Computing @ Carnegie Mellon 3

CIT Requirements (see CIT section of the catalog for specifics):

CIT General Education 72 units 2 semesters of calculus 20
 33-106 Physics I for Engineering Students ⁽¹⁾ 12
 1 other introductory engineering course (generally taken during the freshman year) 12

¹33-106/107 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:

1 Introduction to Electrical and Computer Engineering course (generally taken during the freshman year)
 18-100 Introduction to Electrical and Computer Engineering 12
 1 ECE Seminar, taken during the fall of the sophomore year
 18-200 Emerging Trends in Electrical and Computer Engineering 1
 4 ECE core courses, three with math co-requisites 69
 18-220 Electronic Devices and Analog Circuits 12
 18-290 Signals and Systems 12
 18-202 Mathematical Foundations of Electrical Engineering (co-requisite to 18-220 and 18-290) 12
 18-240 Structure and Design of Digital Systems 12
 21-127 Concepts of Mathematics (co-requisite to 18-240) 9
 18-243 /15-213 Introduction to Computer Systems 12
 2 Breadth Courses from 2 of the 5 Breadth areas within ECE 24
 1 Depth Course (with a Breadth course as a prerequisite) 12
 1 Coverage Course (any additional ECE course or Approved CS course as listed on the ECE web site) 12
 1 Capstone Design Course (any 18-5xx course) 12

Other ECE Requirements:

15-123 Effective Programming in C and UNIX (prerequisite to 18-243/15-213) 9
 33-107 Physics II for Engineering Students 12
 15-110 Principles of Computing 10
 2 Math/Science electives 18
 36-217 Probability Theory and Random Processes 9
 or 36-225 Introduction to Probability Theory (9 units)
 Free Electives 60

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 09-103, 09-104, 21-257, 33-124, 36-201, 36-202, 36-207 and 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:

21-228 Discrete Mathematics 9
 21-259 Calculus in Three Dimensions 9
 21-260 Differential Equations 9

Free Electives

[60 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 and the Software Engineering Institute. A total of at least 60 units of Free Electives must be taken.

Substitutions of courses from other high-quality universities may be accepted through submission of the Transfer Credit Request form on the CIT web page.

Up to 9 units of ROTC and Physical Education courses or other courses taken as Pass/Fail may also be used toward Free Electives.

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:

Freshman Year		Sophomore Year	
Fall	Spring	Fall	Spring
18-100 Introduction to Electrical and Computer Engineering	Introductory Engineering Elective	18-200 Emerging Trends in Electrical and Computer Engineering	ECE Core Course
15-110 Principles of Computing	33-106 Physics I for Engineering Students	ECE Core Course	Concepts of Mathematics / Mathematical Foundations of EE
Calculus	Calculus	Mathematical Foundations of EE / Concepts of Mathematics	15-123 Effective Programming in C and UNIX
Expression / Writing Course	General Education Course	33-107 Physics II for Engineering Students	General Education Course
Computing @ Carnegie Mellon		General Education Course	Free Elective

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
ECE Core Course	ECE Core Course	ECE Coverage Course	ECE Capstone Course
ECE Breadth Course 1	ECE Breadth Course 2	ECE Depth Course	General Education Course
Probability and Statistics	Math/Science Elective 1	Math / Science Elective	Free Elective
General Education Course	General Education Course	General Education Course	Free Elective
Free Elective	Free Elective	Free Elective	Free Elective

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 the ECE Undergraduate 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 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) either.

If a student is at least a 2nd semester junior, has completed at least 270 units and has at least a 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.

Professional MS Degree Requirements:

Please see the ECE web site for the requirements for the Professional MS degree. 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

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Department of Engineering and Public Policy

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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 effectively 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 responsiveness 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. Typically, they require the additional unit equivalent of less than one course. 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 includes 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 H&SS 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, Adrian Perrig, Marvin Sirbu
- Engineering and Public Policy: Liz Casman, Erica Fuchs, Deanna Matthews
- Mechanical Engineering: Jeremy Michalek, Allen Robinson, Edward Rubin
- Material Science and Engineering: Jay Whitacre
- Social and Decision Sciences: Wandi Bruine de Bruin, Paul Fischbeck, Baruch Fischhoff

Double Major Curricula

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, CivE, 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 department. However, 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 curricula on the following pages illustrate, there are substantial differences between elective course requirements for the double major and single major students.

Field	Single Major	Double Major with EPP
Chemical Engineering	386	392
Civil Engineering	379	388
Computer Science	361	370
Electrical & Computer Engineering	379	382
Materials Science and Engineering	379	385
Mechanical Engineering	380	387

The EPP curriculum consists of the following courses:

19-102	EPP Sophomore Seminar	3
19-451	EPP Projects	12
19-452	EPP Projects	12
73-100	Principles of Economics	9
88-xxx	or 19-xxx Decision Analysis Course	9
36-xxx	Probability and Statistics (2 courses)	18
xx-xxx	4 EPP Technical Electives	36
xx-xxx	4 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 substitutes for a disciplinary seminar course for the primary majors with a seminar requirement. In the Spring of Junior year and Fall of Senior year, each student participates in two 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, H&SS, 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 primary majors require a statistics course, typically or 36-220 Engineering Statistics and Quality Control which will count towards meeting one of the two course requirement. A list of qualifying statistics courses to meet the second course requirement is assemble each semester. The statistic courses fill disciplinary technical elective and free elective course slots in the primary major curricula as follows:

- ChE/EPP majors take 36-220 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.
- ME/EPP majors take 36-220 in place of a technical elective and the second course in place of a free elective.
- MSE/EPP majors take 36-220 as part of their single major curriculum and the second course in place of a technical elective.

EPP Technical Electives

EPP Technical 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, and (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 Technical Electives.

Each student elects four of these courses. A list of qualifying Technical Electives is assembled each semester. The following categories of courses count as Technical Electives:

- 19-xxx EPP departmental courses are considered Technical 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 Technical Electives. Examples include mathematics courses related to optimization, estimation, and related topics.
- Courses on substantive technical issues of relevance to policy analysis are considered Technical 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 as follows. Because several traditional majors cannot accommodate four EPP Technical Electives without overload, EPP counts selected courses in those departments as Technical 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 2 EPP Technical Electives and hence take only two more EPP Technical Electives.
 - Civ E/EPP students count two core mini courses, and 27-357 Introduction to Materials Selection, as one EPP Technical Elective, and take only three more EPP Technical Electives.
 - ME/EPP students count 24-441 Engineering Design II: Conceptualization and Realization as an EPP Technical Elective, and take only three more EPP Technical Electives.
 - MSE/EPP students count 27-401 MSE Capstone Course I as one EPP Technical Elective and take only three more EPP Technical Electives.

If you are pursuing a designated minor as well, the EPP Technical Electives must be chosen from among the courses for the designated minor which are also EPP Technical Electives to prevent unnecessary overloading.

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:

73-100 Principles of Economics 9

Students should complete 73-100 as early as possible, preferably during their freshman year.

Students are also required to complete one decision analysis course from the following list:

Choose one of:
 88-223 Decision Analysis and Decision Support Systems 9
 or 88-302 Behavioral Decision Making (9 units)
 or 19-426 Environmental Decision Making (9 units)

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 generally include:

88-xxx All courses in Social and Decision Sciences
 73-xxx All economics courses in the Undergraduate Economics Program jointly administered with the Tepper School of Business.

IMPORTANT NOTE: Occasionally, these departments may offer a course which we deem unsuitable as a social analysis elective. We will note these courses in the advising packets associated with a particular semester. Students should check their advising packets for unallowable courses.

In addition, in any given semester, offerings may include selected courses in the Department of Architecture, the Department of Design, the Department of History, the Department of Philosophy, the Heinz College, and the Tepper School of Business or other departments. Students should consult the EPP list of Social Analysis electives when it is distributed for each specific semester.

Students should work with their advisors to define specific areas of concentration or to identify a selection of breadth courses. Note that students pursuing an EPP double major will use their Social Analysis electives to replace three categories of CIT electives: the H&SS/CFA Depth Sequence, the Non-technical Electives, and the Free Electives.

The Social Analysis requirements provide an effective "depth sequence" for EPP students. Hence they are not required to complete the CIT depth sequences. However, they must complete the Writing and Cultural Analysis 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 Mark Kieler in the EPP Department about the optimal selection of courses. By planning the four-year curriculum in the freshman year, the student can be sure to get the maximum flexibility, and the maximum advantage from any advanced placement credits he or she may have.

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 freshman and sophomore electives required by the student's other traditional technical department. These requirements 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. Students wishing to pursue EPP are also advised to complete the humanistic studies and Writing/ Expression requirements listed in the section on General Education program for CIT Students. However, the other

distribution requirements - cognition and institutions, depth sequence and other general education elective categories - are replaced by the policy components of the double major curriculum as reflected in the social analysis electives. All EPP students are required to take 73-100 Principles of Economics and should complete this as early as possible.

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 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.

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 course of study will ordinarily require two additional semesters of study beyond that required for the undergraduate degrees 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 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 QPA 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.

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 Heinz College 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 curriculum; (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 Deanna Matthews (Assistant Head, 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 19-601 Information Warfare. 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.

Faculty

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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/ugrad/std_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.

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.

Outcome Definitions for MSE

The Department of Materials Science and Engineering has the following program outcomes that apply to current students; these outcomes will allow our students to be successful in any career choice and achieve the long term objectives of our department.

MSE Outcome A:

An ability to apply a knowledge of mathematics, physics, chemistry, materials and statistics to identify, formulate and solve the problems encountered in the production or application of a material.

MSE Outcome B:

An ability to apply core concepts in materials science (structure, properties, processing and performance) to identify, formulate and solve contemporary materials engineering problems.

MSE Outcome C:

An ability to communicate effectively.

MSE Outcome D:

An ability to design and conduct experiments and to analyze and interpret the data derived from these experiments with an emphasis on relating properties and processing to structure and on relating structure and properties to materials performance.

MSE Outcome E:

An ability to select materials to meet relevant performance criteria during the design of engineered systems and components within realistic constraints.

MSE Outcome F:

An ability to function responsibly and ethically in a professional, multidisciplinary environment as an individual or as a member of a team.

MSE Outcome G:

An ability to employ the techniques, skills and tools of modern materials engineering practice.

MSE Outcome H:

A recognition of the need for lifelong scholarship as the field of materials is continually evolving as new knowledge and materials are developed.

MSE Outcome I:

A knowledge of contemporary issues in the application of materials.

MSE Outcome J:

The broad education necessary to understand the impact of materials engineering solutions in a global and societal context.

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

	Units
Fall	
21-120 Differential and Integral Calculus	10
33-106 Physics I for Engineering Students (#)	12
27-100 Engineering the Materials of the Future *	12
xx-xxx H&SS Elective[1]	9
	43

	Units
Spring	
21-122 Integration, Differential Equations and Approximation	10
15-110 Principles of Computing	10
or 15-121 Introduction to Data Structures (10 units)	
xx-xxx Introductory Engineering Elective	12
xx-xxx H&SS Elective [2]	9
99-10x Computing @ Carnegie Mellon	3
	44

Sophomore Year

	Units
Fall	
21-259 Calculus in Three Dimensions	9
21-126 Introduction to Mathematical Software	3
33-107 Physics II for Engineering Students **	12
27-299 Professional Development I	1
27-215 Thermodynamics of Materials	12
27-201 Structure of Materials	9
27-202 Defects in Materials	9
	55

	Units
Spring	
21-260 Differential Equations	9
09-105 Introduction to Modern Chemistry I **	10
09-101 Introduction to Experimental Chemistry **	3
xx-xxx H&SS Elective [3]	9
27-216 Transport in Materials	9
27-217 Phase Relations and Diagrams	12
27-205 Introduction to Materials Characterization	3
	55

Junior Year

	Units
Fall	
xx-xxx Free Elective [1]	9
33-225 Quantum Physics and Structure of Matter	9
or 09-217 Organic Chemistry I (9 units)	
or 03-121 Modern Biology (9 units)	
xx-xxx H&SS Elective [4]	9
27-399 Professional Development II	1
27-xxx MSE Restricted Elective [1]	9
27-301 Microstructure and Properties I	9
	46

	Units
Spring	
xx-xxx Free Elective [2]	9
xx-xxx Free Elective [3]	9
36-220 Engineering Statistics and Quality Control	9
xx-xxx H&SS Elective [5]	9
27-xxx MSE Restricted Elective [2]	9
27-367 Selection and Performance of Materials	6
	51

Senior Year

	Units
Fall	
xx-xxx Free Elective [4]	9
xx-xxx H&SS Elective [6]	9
xx-xxx H&SS Elective [7]	9
27-499 Professional Development III	1
27-xxx MSE Restricted Elective [3]	9
27-401 MSE Capstone Course I	12
	49

	Units
Spring	
xx-xxx Free Elective [5]	9
xx-xxx H&SS Elective [8]	9
27-xxx MSE Restricted Elective [4]	9
27-xxx MSE Restricted Elective [5]	9
	36

Minimum number of units required for degree: 379

* The Materials in Engineering course 27-100 may also be taken in the spring semester, and must be taken before the end of the sophomore year (the H&SS Elective in the Sophomore Spring may be moved to later in the program to accommodate the 27-100 course).

** These courses must be taken before the end of the sophomore year, but need not be taken in the same order or semester as listed above.

The recommended sequence is 33-106 / 33-107 for Engineering students. However, 33-111 / 33-112 or 33-131 / 33-132 will also meet the CIT Physics requirement.

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.

27-302	Microstructure and Properties II	9
27-322	Processing of Metals	9
27-323	Powder Processing of Materials	9
27-324	Introduction to Polymer Science and Engineering	9
27-311	Polymeric Biomaterials	9
27-312	Metallic and Ceramic Biomaterials	9
27-402	MSE Capstone Course II	12
27-405	Analysis and Prevention of Product Failures	9
27-410	Computational Techniques in Engineering	9
27-325	Polymer Physics and Morphology	9
27-421	Processing Design	6
27-432	Electronic and Thermal Properties of Metals, Semiconductors and Related Devices	9
27-433	Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices	9
27-442	Deformation Processing	9
27-445	Structure, Properties and Performance Relationships in Magnetic Materials	9
27-367	Selection and Performance of Materials	6
27-454	Supervised Reading	Var.
27-512	Diffraction Methods in Materials Science	9
27-530	Advanced Physical Metallurgy	9
27-533	Principles of Growth and Processing of Semiconductors	6
27-542	Processing and Properties of Thin Films	9
27-551	Properties of Ceramics and Glasses	9
27-555	Materials Project I	Var.
27-556	Materials Project II	Var.
27-560	Physical Chemistry of Metallurgical Reactions	9
27-565	Nanostructured Materials	9
27-566	Special Topics in MSE	9
27-582	Phase Transformations in Solids	9
27-591	Mechanical Behavior of Materials	9
27-592	Solidification Processing	9
27-594	Electrochemical Degradation of Materials	9
06-466	Experimental Polymer Science	9
06-609	Physical Chemistry of Macromolecules	9
06-619	Semiconductor Processing Technology	9
12-605	Design and Construction	9
12-411	Engineering Economics	6
12-611	Project Management Construction	9
12-631	Structural Design	12
18-310	Fundamentals of Semiconductor Devices	12
18-412	Field Effect Devices and Technology	12
24-261	Statics	10
24-262	Stress Analysis	12
24-341	Manufacturing Sciences	9
24-361	Intermediate Stress Analysis	10
33-355	Nanoscience and Nanotechnology	9
33-341	Thermal Physics I	10
33-448	Introduction to Solid State Physics	9
39-500	Honors Research Project	Var.
42-444	Medical Devices	9
42-300	Junior BME Research Project	Var.
42-400	Senior BME Research Project	Var.

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	
Spring		Units
Industry 1		0
Summer		Units
21-260	Differential Equations	9
xx-xxx	H&SS Elective [3]	9
xx-xxx	H&SS Elective [4]	9
xx-xxx	H&SS Elective [5]	9
		36

Junior Year

Fall		Units
Industry 2		0
Spring		Units
09-105	Introduction to Modern Chemistry I **	10
09-101	Introduction to Experimental Chemistry **	3
xx-xxx	H&SS Elective [6]	9
27-xxx	MSE Restricted Elective [1]	9
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	12
27-205	Introduction to Materials Characterization	3
		55

Summer		Units
Industry 3		0

Senior Year

Fall		Units
xx-xxx	Free Elective [1]	9
33-225	Quantum Physics and Structure of Matter or09-217 Organic Chemistry I (9 units) or03-121 Modern Biology (9 units)	9
xx-xxx	H&SS Elective [7]	9
27-399	Professional Development II	1
27-xxx	MSE Restricted Elective [2]	9
27-301	Microstructure and Properties I	9
		46
Spring		Units
xx-xxx	Free Elective [2]	9
xx-xxx	Free Elective [3]	9
36-220	Engineering Statistics and Quality Control	9
xx-xxx	H&SS Elective [8]	9
27-xxx	MSE Restricted Elective [3]	9
27-367	Selection and Performance of Materials	6
		51

Summer		Units
Industry 4		6

Fifth Year

	Units
Fall	
xx-xxx Free Elective [4]	9
xx-xxx Free Elective [5]	9
27-499 Professional Development III	1
27-xxx MSE Restricted Elective[4]	9
27-xxx MSE Restricted Elective[5]	9
27-401 MSE Capstone Course I	12
	<hr/> 49

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 have the opportunity to receive simultaneously or be sequentially awarded B.S. and M.S. degrees in MSE by taking an additional 96 units of coursework at Carnegie Mellon. The primary purpose of the Integrated Masters/ Bachelor Degree Program is to provide students with superior breadth and depth in technical material, which will better prepare them for careers in industry. The Integrated Masters/Bachelor Degree Program normally requires an additional academic year of coursework beyond the B.S. Degree Requirements. However, students interested in pursuing the Integrated M.S./B.S. Degrees are encouraged to begin taking some of the required graduate courses before their last year.

Degree Requirements

The following are the additional requirements for the Integrated M.S./ B.S. Degrees over and above the requirements for the B.S. Degree. Note that no course can be counted as satisfying more than one of the requirements listed below and no course used to satisfy the B.S. Degree requirements can be used to satisfy one of the requirements listed below. The requirements total 96 units. The 96 additional units needed to satisfy the M.S. degree component of the Integrated Program can not be used to satisfy any other requirements such as a double major or minor.

1. Course Option (96 units)

27-788 Defects in Materials	6
27-766 Diffusion in Materials	6
27-796 Structure of Materials	6
27-797 Bonding of Materials	6
27-798 Thermodynamics I	6
27-799 Thermodynamics II	6

- plus 60 units of 500 or 700 level Materials Science and Engineering courses.

2. Research Option (30 units, Summer 4th year)

27-788 Defects in Materials	6
27-766 Diffusion in Materials	6
27-796 Structure of Materials	6
27-797 Bonding of Materials	6
27-798 Thermodynamics I	6
27-799 Thermodynamics II	6

- plus 30 units of 500 or 700 level Materials Science and Engineering courses.
- plus 30 units of 27-756 Masters Project (usually taken in the summer of the fourth year).

Qualifications

The Integrated B.S./M.S. Degree Program is available to all undergraduates who maintain a cumulative QPA of 3.0 or better, including the freshman year. Students must also maintain a QPA of 3.0 in courses used to satisfy the requirements of the M.S. degree. No course with a grade lower than C will be counted toward the Master's Degree requirements (those over and above the requirements for the B.S. Degree).

Students (with a cumulative QPA of 3.0 or higher) become eligible to apply to the program during the spring semester of their junior year, or the semester in which they accumulate 280 or more

units, whichever is earlier. Interested students should apply to the Department Head of Materials Science and Engineering prior to February 15 of their junior year.

Although some specific graduate courses are required above, substitutions are permitted within the freedom of the normal requirements for the M.S. degree (see graduate curriculum information for further details). Students interested in a program with a strong research orientation are encouraged to elect 27-402 MSE Capstone Course II as part of their undergraduate program.

Faculty

KATAYUN BARMAN, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1999–.

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–.

MARC 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–.

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, 1989–.

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–.

PHIL CAMPBELL, Senior Research Scientist, Institute for Complex Engineered Systems – Ph.D., The Pennsylvania State University; Carnegie Mellon, 2000–.

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–.

DAVID LAMBETH, Professor, Electrical and Computer Engineering and Materials Science and Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

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 Łódź, Poland; Carnegie Mellon, 1985–.

ALAN MCGAUGHEY, – Ph.D., University of Michigan; Carnegie Mellon, 2005–.

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 SUTER, Professor, Physics – Ph.D., Clark University; Carnegie Mellon, 1981–.

LYNN WALKER, Associate Professor, Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1997–.

NEWELL 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–.

JIAN-GANG ZHU, Professor, Electrical and Computer Engineering – Ph.D., University of California at San Diego; Carnegie Mellon, 1997–.

Department of Mechanical Engineering

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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/fluid 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 or by request at Scaife Hall 416.

Educational Objectives

The highest-level objective of Carnegie Mellon University's mechanical engineering undergraduate program is to make positive, substantive, and lasting contributions to the lives of our students. This overall objective is articulated by the following two program educational objectives:

1. Graduates will recognize that they have obtained a high quality and rigorous technical education that is enriched by a flexible curriculum and interdisciplinary research opportunities.
2. Graduates will have applied their education to pursue successful career paths in either the engineering profession or an alternative field

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 problem
- 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

The Department's program fully meets the requirements of an accredited curriculum in mechanical engineering as certified by the Accreditation Board for Engineering and Technology (ABET).

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
	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
	41

Sophomore Year

Fall	Units
21-259 Calculus in Three Dimensions	9
24-221 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	
	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
	52

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
36-220 Engineering Statistics and Quality Control	9
xx-xxx General Education Course	9
	52
Spring	Units
24-370 Engineering Design I: Methods and Skills	12
24-321 Thermal-Fluids Experimentation and Design	12
24-352 Dynamic Systems and Controls	12
xx-xxx General Education Course	9
	45

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
	48
Spring	Units
xx-xxx Elective OR 24-441 Engineering Design II: Conceptualization and Realization	9
24-xxx Mechanical Engineering Technical Elective 9-12	9
xx-xxx Elective	9
xx-xxx Elective	9
xx-xxx General Education Course	9
	45

Notes on the Curriculum

1. Students need a minimum of 381 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 (10 units)
 - 21-122 Integration, Differential Equations and Approximation (10 units)
 - 33-106 Physics I Engineering Students*
 *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.

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.

4. 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.

5. The communications requirement can be satisfied by completing at least one of the following options:

		Units
24-302	Mechanical Engineering Seminar I - either fall or spring	2
70-340	Business Communications	9
76-270	Writing for the Professions	9

6. Students must enroll in 24-452 Mechanical Systems Experimentation in the fall of their senior year.

7. 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
	or 15-121 Introduction to Data Structures (10 units)	

Mechanical Engineering Technical Electives

We require students to take at least one elective that we offer labeled as "Mechanical Engineering Technical Electives" 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:

Design and Manufacturing

24-201	Engineering Graphics	9
24-341	Manufacturing Sciences	9
24-484	Decision Tools for Engineering Design and Entrepreneurship	12
24-681	Computer-Aided Design	12
24-682	Computer-Aided Engineering	12
24-683	Design for Manufacture and the Environment	12
24-684	Integrated Product Development	12

Mechanical Systems

24-353	Intermediate Dynamics	9
24-355	Kinematics and Dynamics of Mechanisms	9
24-356	Engineering Vibrations	11
24-361	Intermediate Stress Analysis	10
24-451	Feedback Control Systems	12
24-655	Cellular Biomechanics	9
24-657	Molecular Biomechanics	9
24-661	Vibrations of Linear and Dynamic Systems	12

Thermal-Fluid Systems

24-324	Energy and Thermal Systems Analysis	9
24-331	Viscous Flow	10
24-332	Potential Flow Aerodynamics	9
24-333	Gas Dynamics	9
24-415	Microfluidics	9
24-421	Internal Combustion Engines	10
24-424	Energy and the Environment	9
24-425	Combustion and Air Pollution Control	9
24-616	Tribology-Friction, Lubrication and Wear	12

Special Topics

24-380	Special Topics in Mechanical Engineering	9
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We regularly offer these courses 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 Departmental 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 fill these five slots from either the mechanical engineering department, College of Engineering, or any other Carnegie Mellon department. However, students 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 /392	Mechanical Engineering Project	Var.
24-491 /492	Department Research Honors	Var.
24-391 /392	Mechanical Engineering Project	Var.
24-491 /492	Department Research Honors	Var.

Additionally, students enrolled in 24-391/392 do not have an additional QPA (quality point average) requirement for this course. Qualified students enrolled in 24-491/492 are recognized at commencement. To graduate with research honors, students must have a QPA of 3.2 or higher, complete 18 units of 24-491/492 with at least at least a "B" grade, and submit an approved thesis to their faculty research advisor.

Students who complete all requirements for CIT Honors Research will also graduate with research honors. These students must complete 18 units of (39-500) CIT Honors Research under the supervision of a mechanical engineering faculty member.

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 advisor is assigned initially to all new students and will continue to assist with any curriculum questions and registration issues until they graduate.

The department academic advisor 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 dinner 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

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 senior. We can only admit

students who meet all of the program's admissions requirements. We do not offer financial aid for the M.S. degree. Interested students should contact our graduate coordinator 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.
- Have a QPA of at least a 3.0 in these courses
- Not use these courses to satisfy their B.S. requirements
- If necessary, complete up to 24 units of 24-793 Supervised Reading and/or 24-24-794 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 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–.

NADINE N. AUBRY, Raymond J. Lane Distinguished Professor and Department Head – Ph.D, Cornell University; Carnegie Mellon, 2006–.

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, Associate Professor – Ph.D., Rensselaer Polytechnic Institute; Carnegie Mellon, 2003–.

LEVENT BURAK KARA, Assistant Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–.

PHILIP R. LEDUC, Associate Professor – Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002–.

SHAWN LITSTER, Assistant Professor – Ph.D, Stanford University; Carnegie Mellon, 2008–.

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–.

WILLIAM CHARLES MESSNER, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 1993–.

JEREMY J. MICHALEK, Associate Professor – Ph.D., University of Michigan; Carnegie Mellon, 2005–.

O. BURAK OZDOGANLAR, Associate Professor – Ph.D, University of Michigan; Carnegie Mellon, 2004–.

YOED RABIN, Professor – D.Sc., Technion-Israel Institute of Technology; Carnegie Mellon, 2000–.

ALLEN L. ROBINSON, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 1998–.

EDWARD STEPHEN RUBIN, Professor – Ph.D., Stanford University; Carnegie Mellon, 1969–.

KENJI SHIMADA, Theodore Ahrens Professor of Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1996–.

METIN SITTI, Associate Professor – Ph.D., University of Tokyo;
Carnegie Mellon, 2002–.

PAUL SETH STEIF, Professor – Ph.D., Harvard University; Carnegie
Mellon, 1983–.

SHI-CHUNE YAO, Professor – Ph.D., University of California, Berkeley;
Carnegie Mellon, 1977–.

DONGHYUN YOU, Assistant Professor – Ph.D., Stanford University;
Carnegie Mellon, 2009–.

YONGJIE ZHANG, Assistant Professor – Ph.D., University of Texas at
Austin; Carnegie Mellon, 2007–.

Adjunct Faculty

ROBERT REID, – Ph.D., Carnegie Mellon University; .

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–.

The College of Fine Arts

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The College of Fine Arts

Dan J. Martin, Interim Dean
College of Fine Arts, Room 100
Barbara Anderson, Associate Dean
Purnell Center for the Arts 332

Overview

The College of Fine Arts at Carnegie Mellon University was founded in 1905 as the first comprehensive arts learning institution in the United States. For over 100 years it has educated outstanding artists, architects, designers, theater artists and musicians who have made important contributions to culture in the United States and the world. The alumni of the College of Fine Arts have shaped the worlds of television, stage, film, and electronic media; are collected in numerous international museums; have composed for and are performing in and conducting major symphony orchestras, choruses and opera companies throughout the world; have built notable buildings, pioneered innovative sustainable design strategies and created interactive software systems; created significant innovations in graphic and industrial design; and are professors and deans in major arts institutions.

The College of Fine Arts concentrates on the education of professionals in the arts in the broader context of Carnegie Mellon University. Beyond their education in their chosen field, through required and elective course work, students are involved with other disciplines within the College of Fine Arts and within the other colleges of Carnegie Mellon University. Further, the College's location in the Oakland District of Pittsburgh with its broad cultural resources (The Carnegie Museum of Art, the Carnegie Museum of Natural History, The Carnegie Library, the University of Pittsburgh, The Hillman Library, the Frick Fine Arts Building, Phipps Botanical Conservatory, and the public television station WQED) places the College of Fine Arts at the center of a premier cultural environment.

The College of Fine Arts has a 9:1 student faculty ratio which provides a rigorous learning environment. It is a highly spirited federation of schools (Architecture, Art, Design, Drama and Music) made up of students and faculty who have an intense need to create and excel. Interacting among the schools, the University and the wider community are research centers such as the Studio for Creative Inquiry, the Center for Building Performance and Diagnostics and the Center for Arts in Society. The intellectual and artistic life of the College is interwoven with a dense calendar of theater performances, concerts, exhibitions, film and media presentations and lectures by visiting artists, practitioners and scholars.

The College of Fine Arts offers a wide range of professionally oriented majors and minors in each of its schools. In addition, the College offers the Bachelor of Humanities and Arts (BHA, jointly with The College of Humanities and Social Sciences), the Bachelor of Science and Arts (BSA, jointly with the Mellon College of Science), the Bachelor of Computer Science and Arts (BCSA, jointly with the School of Computer Science), and the Master of Arts Management (MAM) and Master of Entertainment Industry Management (MEIM), jointly with the Heinz College). These are presented only briefly below, but a complete listing of the graduation requirements for these programs may be found in the school descriptions later in this section and elsewhere in this volume.

Architecture Office: CFA 201

The School of Architecture offers a five-year NAAB accredited Bachelor of Architecture undergraduate degree for students who seek professional careers in architectural practice. Beyond standard preparation in architectural design, history and representation, its curriculum stresses the centrality of aesthetics, scientific knowledge and tectonic resolution in the education of future practicing professionals. A core of university course work in mathematics, physical sciences, social sciences, writing and history is prerequisite to sequences in design, building and environmental technology, and architectural history. The school offers M.S. degrees in Architecture; Architecture, Engineering & Construction Management; Building Performance and Diagnostics; Computational Design; and Sustainable Design. In addition, the School offers a Masters of Urban Design and a Masters of Tangible Interaction Design. The School of Architecture has a well-known architectural Ph.D. program that provides qualified students with the opportunity to continue their studies in the areas of specialization for which the School is recognized.

Art Office: CFA 300

The primary mission of the School of Art is to develop in the individual student the skills, knowledge, and commitment required to work as an artist in society. The four-year undergraduate program leads to a Bachelor of Fine Arts degree in Art. Concentrations within the art major are offered in four areas: 1) Painting, Drawing, and Printmaking; 2) Electronic and Time-Based Work; 3) Sculpture, Installation, and Site Work; and 4) Contextual Practice. A Master of Fine Arts degree in Art is also offered.

Design Office: MM 110

The School of Design seeks to combine a sound education in the liberal arts with professional study that leads to careers in many fields of design. It offers the following degrees: B.F.A. in Communication Design; B.F.A. in Industrial Design; Master of Design in Interaction Design (with specializations in Human-Computer Interaction Design and Human-Machine Interaction Design); Master of Design in Communication Planning and Information Design (a joint degree with the Department of English); and Master in Product Development (a joint degree with the Department of Mechanical Engineering with support from the Tepper School of Business).

Drama Office: PCA 220

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, Jazz Performance, Music Education, and Music Technology available. The Master of Music is offered in Composition, Performance, Conducting and Music Education.

BXA Intercollege Degree Programs: Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), Bachelor of Computer Science and Arts (BCSA)

Franco Sciannameo, Director
Margaret Morrison Carnegie Hall, Room 107
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 be considered, but may not be able to be processed 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 on p. 48. 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 advisers.

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 page 21 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 advisers 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 (available also to B. Arch candidates)
- Architectural Representation and Visualization (available also to B. Arch candidates)
- Architectural Technology
- Art
- Building Science (available only to B. Arch candidates)
- Communication Design
- Drama
- History of the Arts
- Industrial Design
- Music Performance
- Music Composition
- 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 advisers 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 advisers 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.

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	9
or 62-100 Critical Histories of the Art (9 units)	
Required Courses	18-21 units
48-100 Architecture Design Studio: Foundation I	12
or 48-095 Architecture for Non-Majors I (9 units)	
48-240 Historical Survey of World Architecture and Urbanism	9

Elective Courses*	27 units
48-130 Architectural Drawing I: A Tactile Foundation	9
48-135 Architectural Drawing II: Appearance	9
48-210 Statics	9
48-215 Materials and Assembly	9
48-217 Structures	9
48-351 Human Factors in Architecture	9
48-452 Real Estate Design and Development	9
48-453 Urban Design Methods	9
48-551 Ethics and Decision Making in Architecture	9
48-xxx Architecture History (Pre-Approval of coursework required)	9
48-xxx Architecture Elective (Pre-Approval of coursework required)	9

Minimum Units: 54

*Students should consult the Architecture advisor regarding elective choices.

Minor in Architectural History

(available also to B. Arch Candidates)

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	9
62-100 Critical Histories of the Art	9

Elective Courses	36 units/45 units
48-338 European Cities in the XIX Century: Planning, Architecture, Preservation	9
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 Hornbostel	9
48-345 The Cultural Landscape of Northern Italy: Land, City, Architecture	9
48-348 History of Central American Architecture	9
48-350 Postwar Modern Architecture and Theory	9
48-352 A History of Preservation: Debate, Theories and Practices	9
48-368 Rediscovering Antiquity: Travelers, Archeologists & Architects in Mediterranean	9
48-371 American House and Housing	9
48-440 American Regionalism	9
48-441 Frank Lloyd Wright	9
48-447 History and Preservation	9
48-448 History of Sustainable Architecture	9
48-xxx Architectural History (Pre-Approval of coursework required)	9

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	6
48-130	Architectural Drawing I: A Tactile Foundation	9
48-135	Architectural Drawing II: Appearance	9
48-3xx	Architectural Drawing Elective (Pre-Approval of coursework required)	9

Elective Courses		21 units/30 units
48-125	Introduction to Digital Media II <small>*Architecture majors cannot use 48-125 as an elective requirement</small>	6
48-477	Undergraduate Making things Interactive	9
48-568	Advanced CAD, BIM, and 3D Visualization	9
48-576	Mapping Urbanism	9
48-724	Parametric Modeling	9-12
48-xxx	Architectural Representation/Visualization Elective: (Pre-Approval of coursework required)	9
48-xxx	Architectural Representation/Visualization Elective: (Pre-Approval of coursework required)	9

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	Performance of Advanced Building Systems	9
48-728	Special Topics in BPD: POE Environmental Assessment Tools and Analysis	6
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

Minor in Art

Concept Studio (choose one)		10 units
60-101	Concept Studio I	10
60-201	Concept Studio III	10
This course renamed Concept Studio II		
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	3-D Media Studio I	5
60-131	3D Media Studio II	5
60-150	2D Media Studio: Drawing	10
60-160	2D Media Studio: Imaging	10
60-250	2D Media Studio: Painting	10

Advanced Media (choose two)		20 units
60-4xx	Advanced ETB: Electives	10
60-4xx	Advanced SIS: Electives	10
60-4xx	Advanced PDP: Electives	10

Art History/Theory (choose one)		9 units
60-1xx	Art History Elective	9
60-2xx	Art History Elective	9
60-3xx	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 (pre-requisite for all advanced architecture classes below)	9
51-271	Design History I	9
54-239	History of Architecture and Decor	Var.
54-245	History of Clothing	Var.

54-246	History of Clothing	Var.
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 Hornbostel	9
48-345	The Cultural Landscape of Northern Italy: Land, City, Architecture	9
48-348	History of Central American Architecture	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	History of Drama	6
54-382	History of Drama	3
57-209	The Beatles	9
57-477	Music of the Spirit	6
57-478	Survey of Historical Recording	6
60-350 to 60-398	Art History/Theory Special Topics (instructor permission only)	9
62-360	/79-360 Photographers and Photography Since World War II	9
62-371	/79-372 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).

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 (fall or spring)	9
51-271	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.

Required Courses 18 units

51-263	Industrial Design Fundamentals (fall or spring)	9
51-271	Design History I (fall)	9

Elective 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 the courses.

minimum units required: 54

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, and a series of related Theatre History 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. Students must apply to enter the program in the office of the Drama Advisor, PCA 223.
2. The student must successfully pass one Drama course prior to being considered for minor status.

Required Courses 25 units

54-163 /164	Production for Non Majors	6
54-177	Foundations of Drama I	6
54-178	Foundations of Drama I	6
54-175 /176	Conservatory Hour	1

Students must meet with the School of Drama Production Manager (PCA 224) for assignments related to Production for Non-Majors.

Elective Courses 30 units

The remainder of the minor is fulfilled with Drama courses of the student's choosing, with approval from the Academic Coordinator of the School of Drama. For certain courses, students may need instructor permission to register.

Elective Courses not requiring instruction permission:

54-187 /188	Introduction to Playwriting	9
54-189 /190	Advanced Playwriting	9
54-191 /192	Acting for Non-Majors	9
54-193 /194	Introduction to Screenwriting	9
54-195 /196	Advanced Screenwriting	9

Selected Elective Courses requiring instructor permission:

54-109	Dramaturgy I: Approaches to Text	Var.
54-121	Directing I: Sources	9
54-157	Basic PTM	6
54-169	Studiocraft	13
54-171	Basic Design	6

Additional Drama Courses are available by instructor agreement and may require an audition, interview, or portfolio review. Students should contact the Drama Academic Coordinator to inquire about permission for specific courses in which they are interested.

minimum units required: 55

Minor in Music Performance / Music (Composition)

This sequence is for candidates who are majors from any discipline in the university other than music who have professional potential demonstrated by an acceptable audition and would like to improve their performance skills, but who have chosen to pursue a major other than music.

Admission Requirements:

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
2. The student must perform an acceptable audition. Requirements for the audition can be found in the Admission section of the Undergraduate Catalog.

Prerequisite Course 3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-329 Beginning Piano for Minors 3

Introductory Courses 25 units

57-161	Eurhythmics I	3
57-181	Solfege I	3
57-152	Harmony I	9
57-173	Survey of Western Music History	9
	57-188 Repertoire and Listening for Musicians	1

Required Studio Courses 24 units

57-496	Minor Studio	6
57-497	Minor Studio	6
57-498	Minor Studio	6
57-499	Minor Studio	6

Elective Courses (for non-voice minors) 24 units

Elective courses are to be chosen from those course 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.)

Required Language Courses (for voice minors) 18 units

Language course (choose 1)

82-101	Elementary French I	12
82-121	Elementary German I	12
82-161	Elementary Italian I	12

Diction Course (choose 1)

An introductory course in the applicable language is a coerequisite for each of these countries.

57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3

Literature and Repertoire Course (choose 1)

An introductory course in the applicable language is a prerequisite for each of these countries.

57-431	Italian Literature and Repertoire	3
57-432	French Literature and Repertoire	3
57-435	German Literature and Repertoire	3

Elective Courses (for voice minors) 6 units

These courses are to 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.) Additional language, diction, and literature and repertoire electives are encouraged for voice minors.

Minimum units required: 73

Minor in Music Technology

This sequence is for candidates who are music majors; art, design, or drama majors who are interested in recording, sound-editing and other music technology areas (in addition to courses in their home schools); or majors from any discipline in the university who have some background in music and would like to know more about music technology.

Admission Requirements

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Course 3 units

Computing @ Carnegie Mellon must be passed before taking any of the required technology courses. Beginning Piano is required of students who do not pass a piano proficiency test.

99-10x	Computing @ Carnegie Mellon	3
57-329	Beginning Piano for Minors	3

Introductory Music Courses 19 units

57-152	Harmony I	9
57-173	Survey of Western Music History	9
	57-188 Repertoire and Listening for Musicians	1

Required Music Technology Courses 33 units

57-101	Introduction to Music Technology	6
57-337	Sound Recording	6
57-338	Sound Editing and Mastering	6
57-347	Electronic and Computer Music	6
57-438	Multitrack Recording	9

Technical Courses (choose 2) 15 units

15-110	Principles of Computing	10
15-323	Computer Music Systems and Information Processing	9
33-114	Physics of Musical Sound	9
54-509	Advanced System Design	9
54-666	Production Audio	6
57-610	Internship	Var.

Minimum units required: 67

Minor in Music Theory

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 theory.

Admission Requirements

The student must apply to enter the program in the office of the Directory of Student Services (CFA 108).

Prerequisite Courses 3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-329 Beginning Piano for Minors 3

Introductory Courses 25 units

57-152	Harmony I	9
57-161	Eurhythmics I	3
57-173	Survey of Western Music History	9
57-181	Solfège I	3
57-188	Repertoire and Listening for Musicians	1

Required Theory Courses 27 units

57-151	Concept and Practice of Counterpoint	6
57-153	Harmony II	9
57-257	Orchestration I	6
57-408	Form and Analysis	6
57-612	Independent Study in Theory	Var.

Analysis Course (choose 1) 6 units

57-258	20th-21st Century Techniques	6
57-442	Analytical Techniques	6

Minimum units required: 58

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 Gruzka, MM B18, for further information and an application form.

Photography Required Courses (3) 27 units

62-141 /60-141/51-265	Black and White Photography I ***	9
62-241	Black and White Photography II	9
62-381	Color Photography and Digital Output	9

Photography Elective (1) 9 units

Choose one (1) additional photography course from the list below in consultation with the photo advisor, or consult Jamie Gruzka for current offerings. Also, photo courses may be taken at Pittsburgh Filmmakers. Please refer to their course catalog that is available in the CFA Dean's Office, CFA 100, or online: pghfilmmakers.org

51-338	Documentary Photography	9
62-245	Portrait Photography	9
62-265	Alternative Photo Processes	9
62-337	Studio Lighting	9
62-325	View Camera	9

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 (9 units)	

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

www.cmu.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 498 units is required for graduation in the undergraduate program (504 with thesis). 48-505 Studio X must be taken and passed.

*In the United States, most 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 US professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture and the Master of Architecture and the Doctor of Architecture. A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with the established educational standards. Masters degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, that when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree (National Architecture Accrediting Board Conditions and Procedures 2004).

Curriculum

First Year

48-100	Architecture Design Studio: Foundation I	12
48-120	Introduction to Digital Media I	6
48-130	Architectural Drawing I: A Tactile Foundation	9
48-240	Historical Survey of World Architecture and Urbanism	9
62-175	Descriptive Geometry	6
99-10x	Computing @ Carnegie Mellon	3
48-105	Architecture Design Studio: Foundation II	12
48-125	Introduction to Digital Media II	6
48-116	Building Physics	9
48-135	Architectural Drawing II: Appearance	9
76-101	Interpretation and Argument	9

Second Year

48-200	Architecture Design Studio: Composition	18
48-210	Statics	9
48-xxx	Architectural History II	9
48-xxx	School Elective (1)	9
xx-xxx	University Elective (1)	9
48-205	Architecture Design Studio: Materials	18
48-215	Materials and Assembly	9
48-217	Structures	9
62-100	Critical Histories of the Art	9
xx-xxx	University Elective (2)	9

Third Year

48-300	Architecture Design Studio: Site	18
48-312	Site Engineering and Foundations	6
48-315	Environment I: Climate & Energy	9
48-xxx	School Elective (2)	9
xx-xxx	University Elective (3)	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
48-xxx	School Elective (3)	9
xx-xxx	University Elective (4)	9

Fourth Year

48-400	Architecture Design Studio: Occupancy	18
48-412	Environment II: Mechanical Systems	9
48-xxx	Architectural History III	9
48-xxx	School Elective (4)	9
xx-xxx	University Elective (5)	9
48-405	Architecture Design Studio: Systems Integration	18
48-415	Advanced Building Systems	6
48-452	Real Estate Design and Development	9
48-xxx	School Elective (5)	9
xx-xxx	University Elective (6)	9

Fifth Year

48-500	Architecture Design Studio: The Urban Laboratory	18
48-497	Thesis I	6
48-550	Issues of Practice	9
48-453	Urban Design Methods	9
48-xxx	School Elective (6)	9
48-505	Studio X	18
48-xxx	School Elective (6)	9
48-xxx	School Elective (7)	9
xx-xxx	University Elective (7)	9

Total number of units required: ⁽¹⁾ 504

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.

-		
62-100	Critical Histories of the Art	9
62-175	Descriptive Geometry	6
76-101	Interpretation and Argument	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: Site	18
48-305	Architecture Design Studio: Advanced Construction	18
48-400	Architecture Design Studio: Occupancy	18
48-405	Architecture Design Studio: Systems Integration	18
48-500	Architecture Design Studio: The Urban Laboratory	18
48-505	Studio X	18

History (1+3 courses)

In addition to Critical Histories of the Arts, taken during the second year, three core courses in architectural history are required for the Bachelor of Architecture degree. All first year students must complete the Historical Survey of World Architecture & Urbanism, which focuses on the major monuments of western civilization, as well as highlighting non-western and vernacular traditions. Two additional core courses on the history of architecture are required. These two courses must be taken within the School of Architecture and must have been designated as satisfying the core requirements. The core architectural history courses consider more specific topics and are intended to provide students with advanced skills in investigating architecture from the historical perspectives of culture, society, politics, religion, economics, theory, and/or technology. These courses are also intended to develop research and writing skills.

In addition to the three core architectural history courses, elective courses on additional topics of architectural history may also be taken. With approval of the specific electives, students completing four additional nine-unit architectural history and theory courses beyond the three required may graduate with a minor in Architectural History.

48-240	Historical Survey of World Architecture and Urbanism	9
62-100	Critical Histories of the Art	9
48-xxx	Architectural History	9
48-xxx	Architectural History	9

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.

48-120	Introduction to Digital Media I	6
48-125	Introduction to Digital Media II	6
48-130	Architectural Drawing I: A Tactile Foundation	9
48-135	Architectural Drawing II: Appearance	9

Technology: Building, Materials, and Structures (5 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

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.

48-116	Building Physics	9
48-210	Statics	9
48-215	Materials and Assembly	9
48-217	Structures	9
48-312	Site Engineering and Foundations	6

Technology: Environment/ Sustainability (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.

48-315	Environment I: Climate & Energy	9
48-412	Environment II: Mechanical Systems	9
48-415	Advanced Building Systems	6

Professional Practice, Ethics, Management (5 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.

48-351	Human Factors in Architecture	9
48-452	Real Estate Design and Development	9
48-453	Urban Design Methods	9
48-550	Issues of Practice	9
48-551	Ethics and Decision Making in Architecture	9

School Electives (7 Courses)

A minimum of seven school electives is required for the Bachelor of Architecture degree. The general goal of the school electives is to build knowledge of architecture within the broad context of society; specifically, in light of economic, social, technological, political, and cultural forces. A more specific goal is to build in-depth knowledge and skill in an area of interest to the student.

University Electives (7 courses)

The school considers elective courses to be crucial for the intellectual breadth of an architect as a citizen in contemporary society. In this spirit, the School urges its students to use these courses as an opportunity to take advantage of the unique strengths of Carnegie Mellon University and to develop ties to other disciplines.

Dual Degrees

Students in the School of Architecture can pursue a dual degree program in the Tepper School of Business' undergraduate business program, Engineering at Carnegie Institute of Technology (CIT), History in Humanities & Social Sciences (H&SS), and Industrial Design in the School of Design. Other dual degree programs are possible and encouraged.

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 concentration to receive a 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 seven electives in other departments, 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 depth 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.

5 + 1 Masters Degree Options

The School of Architecture offers a unique opportunity to undergraduate students who wish to pursue a Masters degree in an architecture-related field. Undergraduate students may begin taking graduate-level courses in their 4th and 5th year of study. This allows students to graduate with a Masters degree in only one additional year of study beyond their 5-year undergraduate program.

Masters of Science in Computational Design

The Master of Science (MS) program in Computational Design is designed primarily for practitioners in the building industry who wish to broaden their knowledge about state-of-the-art computer approaches and applications to the architectural and building sciences and for individuals who wish to pursue research careers in these areas. The program covers, in depth, a range of computational design issues and culminates with a project in which students are asked to apply the knowledge they have acquired to realistic problems.

Masters of Science in Building Performance and Diagnostics

The Master of Science (MS) program specialized in Building Performance and Diagnostics is intended for practitioners, researchers and educators in architecture and the building industry who wish to be leaders in advanced building technologies and their performance. The program covers, in depth, knowledge concerning state-of-the-art approaches to building systems integration and total building performance. The program culminates with a project in which students must apply the knowledge they have acquired to realistic problems, using the appropriate analytical and modeling skills.

Masters of Urban Design

The 12-month postprofessional Masters of Urban Design program prepares graduates for careers using design to address environmental, economic, social, and cultural issues affecting the contemporary metropolis critically. Studios explore strategies for sustainable development in a variety of settings including the shrinking postindustrial city, the suburban periphery, and the rapidly urbanizing region. Pittsburgh-based studios emphasize citizen engagement and participatory design, exploring problems of urban neighborhood revitalization, infrastructure development and suburban transformation, in partnership with the Remaking Cities Institute. The studio sequence is supported by core courses in urban history and theory, geographic analysis, sustainable community development and real estate.

Masters of Science of Tangible Interaction Design

The Master of Tangible Interaction Design (mTID) is designed primarily for those with a background to acquire the technical skills to realize embedded computing designs, and those with computer science and engineering backgrounds to apply their knowledge in design. The program includes coursework in software, electronics, and fabrication techniques for building working prototypes of tangible embedded interactive systems.

Masters of Science in Sustainable Design

The M.S. in Sustainable Design program builds on the expertise within our world-renowned research center, the Center for Building Performance and Diagnostics, to provide an integrated education intended to prepare its graduates for careers that will reshape the built environment in a sustainable fashion. The program addresses the crossdisciplinary nature of sustainable design and is designed

to meet the unique needs of those with prior experience in design and construction fields such as architecture, landscape architecture, engineering, construction, project design, and ecology. The program culminates with a project in which students must apply the knowledge they have acquired to realistic problems, using the appropriate analytical and modeling skills.

Masters of Science in Architecture-Engineering Construction Management

The Masters of Science (MS) program in Architecture-Engineering Construction Management is offered jointly with the Department of Civil Engineering and aims to prepare building delivery professionals civil engineers, construction planners, facility managers, developers, architects, planners, landscape architects, interior designers, and other building consultants for careers in the management of design, construction, maintenance, and used of facilities. By focusing on the decision making process, the program educates professional in ways to positively impact economic, environmental, and ethical concerns inherent in the delivery of construction projects.

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 (<https://acis.as.cmu.edu/gale2/audit/degreaudit.html>)

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, Jan 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. Valentour Traveling Scholarship Fund, Luther Lashmit Award, Burdett Assistantship, and the Lewis J. Altenhof Memorial Scholarship.

Study Away Program

The School of Architecture conducts an officially recognized exchange program for students to study abroad at the EPFL in Lausanne, Switzerland; ITESM in Monterrey, Mexico; and the National University of Singapore. 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 Studio X in their fourth-year or thesis in their fifth-year.

Students are also welcome to seek out the many other study abroad 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 abroad, 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 abroad by the fall of their second year, so they can plan their courses accordingly. Students are allowed one semester abroad for which they receive studio credit except for those students at year-long direct exchange programs. To qualify for study abroad, a student must have completed the third-year of their program, have a minimum overall QPA 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, Adjunct Associate Professor BArch, Aechtitructural Association; Carnegie Mellon, 2007.

MARTIN AURAND, Principal Architecture Librarian/Archivist MLIS, University of Pittsburgh; Carnegie Mellon, 1987.

AZIZAN AZIZ, Adjunct Instructor, Senior Researcher, CBPD MS Building Performance & Diagnostics, Carnegie Mellon University; Carnegie Mellon, 1997.

TERESA BUCCO, Adjunct Assistant Professor MArch, North Carolina State University; Carnegie Mellon, 2002.

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 SMArchS, 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, Adjunct Professor BArch, Syracuse University; Carnegie Mellon, 1996.

STEFANIE 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.

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.

KEVIN GANNON, Adjunct Professor MArch, Yale University; Carnegie Mellon, 1996.

PABLO GARCIA, L. & R. Caste Professor in Architecture & Urban Design MArch, Princeton University; 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.

HAL HAYES, Adjunct Associate Professor BArch, Carnegie Mellon University; Carnegie Mellon, 2008.

DELBERT HIGHLANDS, Professor Emeritus MArch, Carnegie Mellon University; Carnegie Mellon, 1985.

KELLY HUTZELL, Assistant Teaching Professor MS Architecture and Urban Design, Columbia University; Carnegie Mellon, 2005.

DONALD JOHNSON, Adjunct Assistant Professor MArch, Yale University; Carnegie Mellon, 2006.

JEFFREY KING, Adjunct Professor MArch, Tulane University; Carnegie Mellon, 2004.

JONATHAN KLINE, Adjunct Assistant 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.

LAURA LEE, Professor MArch, University of Michigan; Carnegie Mellon, 1989.

STEPHEN LEE, Professor and Head MArch, Carnegie Mellon University; Carnegie Mellon, 1985.

DAVID LEWIS, Teaching Professor Emeritus MArch, Leeds College of Architecture; Carnegie Mellon, 1982.

CINDY LIMAURO, 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.

JENNIFER LUCCHINO, Adjunct Associate Professor MArch, Rice University; Carnegie Mellon, 2003.

GERRY MATTERN, Adjunct Professor B.E., Rose Polytechnic Institute; Carnegie Mellon, 1982.

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.

PAUL ROSENBLATT, Adjunct Associate Professor MArch, Yale University; Carnegie Mellon, 1987.

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.art.cfa.cmu.edu>

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. The School of Art is a charter member of the National Association of Schools of Art and Design (NASAD) and is fully accredited by this organization.

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

Studio courses comprise over sixty percent of the course of study and academic courses comprise the remainder. The division of the studio curriculum into conceptually-driven and media-driven courses acknowledges that neither concept nor media can be presented independently of one another. This curriculum ensures that all students experience high-quality, consistent training in a variety of approaches.

I. Concept Studios

The Concept Studios are the core of the art curriculum. Students are required to complete six concept studios, but may enroll in additional semesters. In the second semester of the junior year, a Concept Studio is optional. Experiences gained in the other four components of the program are integrated into Concept Studios. Themes and topics addressed in Concept Studios include: the self and the human being, space/time, systems/processes, contextual practice, and senior studio.

Freshman and sophomore Concept Studios are organized around structured assignments designed to assist the student in developing a personal, non-medium-specific approach to generating art as well as in learning transferable conceptual skills. The progression from semester to semester leads toward increasing complexity and independence. In the junior year, the Contextual Practice Studio is devoted entirely to context-related issues and art that engages a variety of communities or organizations. In the senior year, the Concept Studios, titled Senior Studio, are devoted to a single student-generated body of work.

II. Media Studios

The Media Studios can be viewed as the foundation courses for the program. Students take a total of seven Media Studios within the freshman year and the first semester of the sophomore year. These studios ensure that all students have an exploratory experience with all of the media resources of the school. They also serve as preparation for advanced studio work.

Two-Dimensional Media Studios introduce drawing and imaging during the freshman year, and painting during the sophomore year. Electronic Media Studios introduce video work during the freshman year, and computer-related work in the sophomore year. Three-Dimensional Media Studios introduce media such as ceramics, welding, wood, metals, and mixed media during the freshman year.

III. Advanced Studios

Students take a total of nine Advanced Studio elective courses over the course of the second semester of the sophomore year and the junior and senior years. These courses address specialized studio work in one of the four artistic concentration areas in the school, which are:

- Drawing, Painting, Print Media, and Photography (DP3)
- Sculpture, Installation, and Site Work (SIS)
- Electronic and Time-Based Work (ETB)
- Contextual Practice (CP)

A minimum of four courses must be taken in one of these concentration areas. One of the nine Advanced Studio courses must be a College of Fine Arts interdisciplinary course or in one of the Schools outside of Art: Architecture, Design, Drama, Music.

IV. Academic Art Courses

First-semester freshmen are required to take Contemporary Issues Forum (60-104), an introduction to current practices in the visual arts. A three-semester art history/theory survey sequence is then required of all students:

Freshman Year (spring):	Critical Histories of the Arts
Sophomore Year (fall):	Modern Visual Culture: 1789-1945
Sophomore Year (spring):	Contemporary Visual Culture: 1945
	to the Present

After the sophomore year, students must take two elective academic art courses.

V. University Academic Courses

Eleven academic courses outside of Art are required.

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 take one course in each of the following academic areas or options:

- Humanities and Languages or Culture Option
- Math, Science and Engineering or Technical Option
- History, Psychology, Economics or Social Science Option

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

Fall	Units
60-101 Concept Studio I	10
60-130 & 60-130 3-D Media Studio I-I Mini 1 and Mini 2 must be in different media.	10
60-150 2D Media Studio: Drawing	10
60-104 Contemporary Issues Forum	6
76-101 Interpretation and Argument	9
99-101 Computing @ Carnegie Mellon	3
	48

Spring	Units
60-110 Electronic Media Studio I	10
60-131 & 60-131 3D Media Studio II-II Mini 3 and Mini 4 must be in different media.	10
60-160 2D Media Studio: Imaging	10
62-100 Critical Histories of the Art	9
79-104 Global Histories	9
	48

Second Year

Fall	Units
60-20x Concept Studio II	10
60-210 Electronic Media Studio II	10
60-250 2D Media Studio: Painting	10
60-205 Modern Visual Culture 1789-1945	9
xx-xxx Academic Elective	9
	48

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
	48

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
	48

Spring	Units
60-4xx Advanced Studio 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
	48

Fourth Year

Fall	Units
60-401 Senior Studio	20
60-4xx Advanced Studio Elective	10
xx-xxx Academic Elective	9
xx-xxx Academic Elective	9
	48

Spring	Units
60-402 Senior Studio	20
60-4xx Advanced Studio Elective	10
xx-xxx Academic Elective	9
xx-xxx Academic Elective	9
	48

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 Minor 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:

- Brazil Escola de Comunicacoes e Artes, Universidade de Sao Paulo, Sao Paulo
- Chile Instituto Superior de Arte y Comunicacion, Santiago
- China Chinese University of Hong Kong, Shatin, Hong Kong
- Denmark The Royal Danish Academy of Fine Arts, Copenhagen
- Ecuador Universidad de San Francisco de Quito, Quito
- Finland Kuvataideakatemia, Helsinki
- France Ecole d'Aix-en Provence, Aix-en Provence
Ecole nationale superieure des Beaux-Arts, Paris
- Germany Akademie der Bildenden Kunste, Munich
Universitat der Kunste Berlin, Berlin
University of Applied Sciences, Hamburg
University of Applied Sciences, (Kunstseminar) Schwabisch Hall
University of Applied Sciences, Wedel
- Ireland Burren College of Art and Design, Burren
- Israel Bezalel Academy, Jerusalem
- Japan College of Art and Design, Nagoya
Tokyo Polytechnic University, Tokyo
- Korea The Korean National University of the Arts, Seoul
- Netherlands Gerrit Rietveld Academie, Amsterdam
- New Zealand Auckland Institute of Technology, Auckland
- Scotland Duncan Jordanstone College of Art and Design, Dundee
Glasgow School of Fine Art, Glasgow
- Spain Universitat Politecnica de Valencia, Valencia
- Turkey Bilkent University, Ankara
- Wales University of Wales College, Newport

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.

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.art.cmu.edu>.

Master of Arts Management (M.A.M.) Degree

The College of Fine Arts and the H. John Heinz III 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 MERRELL, Associate Professor of Art M.F.A., Yale University; Carnegie Mellon, 1998.

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, Assistant 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

JILL MILLER, Visiting Assistant Professor of Art M.F.A., University of California, Los Angeles Carnegie Mellon; Carnegie Mellon, 2000.

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 ELDRIDGE, 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		Units
51-101	Design Studio I	9
		9
Ideas and Methods		Units
51-121	Design Drawing I	9
		9
Design Studies		Units
51-171	Human Experience in Design	9
		9

General Education	Units
76-101 Interpretation and Argument	9
85-102 Introduction to Psychology	9
99-101 Computing @ Carnegie Mellon	3
or99-102 Computing @ Carnegie Mellon (3 units)	
<hr/>	21

Spring

Studio	Units
51-102 Design Studio II	9
<hr/>	9

Ideas and Methods	Units
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
<hr/>	18

Design Studies	Units
62-100 Critical Histories of the Art	9
<hr/>	9

General Education	Units
79-104 Global Histories	9
<hr/>	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

Studio	Units
51-201 Basic Typography Communication Design I	9
<hr/>	9

Ideas and Methods	Units
51-203 Communication Design Computer Lab	3
51-241 How People Work	9
51-229 Digital Photographic Imaging	9
<hr/>	21

Design Studies	Units
51-271 Design History I	9
<hr/>	9

General Education	Units
xx-xxx Academic Elective	9
<hr/>	9

Spring

Studio	Units
51-202 Intermediate Typography	9
<hr/>	9

Ideas and Methods	Units
51-222 Color and Communication	9
51-224 Production for Designers, From Pixels to Print	9
<hr/>	18

Design Studies	Units
51-272 Design History II	9
<hr/>	9

General Education	Units
xx-xxx Academic Elective	9
<hr/>	9

Third Year

Fall

Studio	Units
51-301 Advanced Typography CD III	9
<hr/>	9

Ideas and Methods	Units
51-321 Photographic Narrative	9
51-323 Drawing and Communication	9
51-327 Introduction to Web Design	9
51-333 Poster Design	9
<hr/>	36

Design Studies	Units
51-371 /398 Design & Social Change	6
<hr/>	6

Other	Units
51-399 Junior Independent Study	Var.
<hr/>	0

General Education	Units
xx-xxx Academic Elective	9
xx-xxx Free Elective	9
<hr/>	18

Spring

Studio	Units
51-302 Typography IV	9
<hr/>	9

Ideas and Methods	Units
51-324 Basic Prototyping (for Communication Design)	4.5
51-330 Photo Book Design	9
51-350 Visualization	9
<hr/>	22.5

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Design Studies	Units
Topics in Design Studies course 51-372 through 51-398	9
	<hr/> 9

Other	Units
51-399 Junior Independent Study	Var.
	<hr/> 0

General Education	Units
xx-xxx Academic Elective	9
xx-xxx Free Elective	18
	<hr/> 27

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

Studio	Units
51-211 Generation of Form: Industrial Design I	9
	<hr/> 9

Ideas and Methods	Units
51-241 How People Work	9
51-243 Prototyping (mini 1)	4.5
51-251 Digital Prototyping (mini 2)	4.5
	<hr/> 18

Design Studies	Units
51-272 Design History II	9
	<hr/> 9

General Education	Units
xx-xxx Academic Elective	9
	<hr/> 9

Spring

Studio	Units
51-212 Meaning of Forms: ID Studio II	9
	<hr/> 9

Ideas and Methods	Units
51-242 How Things Work: Mechanics and Electronics	9
51-246 Photo Documentation	4.5
	<hr/> 13.5

Design Studies	Units
51-274 Design and Social Change	9
	<hr/> 9

General Education	Units
xx-xxx Academic Elective	9
xx-xxx Free Elective 3-9	9
	<hr/> 18

Third Year

Fall

Studio	Units
51-311 Product Design ID III	9
	<hr/> 9

Ideas and Methods	Units
51-341 How Things are Made	9
51-327 Introduction to Web Design	9
	<hr/> 18

Design Studies	Units
51-371 & 51-398 Design & Social Change - Methodology of Visualization	10.5
	<hr/> 10.5

Other	Units
51-399 Junior Independent Study	Var.
	<hr/> 0

General Education	Units
xx-xxx Academic Elective	9
xx-xxx Free Elective	9
	<hr/> 18

Spring

Studio	Units
51-312 Products in Systems: ID IV	9
	<hr/> 9

Ideas and Methods	Units
51-344 Advanced Digital Prototyping	6
51-346 Production Prototyping	6
51-350 Visualization	9
	<hr/> 21

Design Studies	Units
51-371 & 51-398 Design & Social Change - Methodology of Visualization	10.5
	<hr/> 10.5

Other	Units
51-399 Junior Independent Study	Var.
	<hr/> 0

General Education	Units
xx-xxx Academic Elective	9
xx-xxx Free Elective	9
	<hr/> 18

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.)

Studio		Units
51-403	Senior Project: Interaction Design	12
51-405	Senior Project: Communication Design	12
51-407	Senior Project: Social Impact by Design	12
51-409	Senior Project: Environmental Design	12
		<hr/> 48
Ideas and Methods		Units
51-421	Basic Interaction	9
51-423	Introduction Computing in Design	9
51-433	Advanced Interaction	9
51-451	Fundamentals of Joinery & Furniture Design (I)	9
51-441	Product Planning & Development	4.5
51-426	Beginning Book Arts Lab	9
		<hr/> 49.5
Design Studies		Units
51-471	Practicing Design	9
51-441	Product Planning & Development	4.5
		<hr/> 13.5
Other		Units
51-499	Senior Independent Study	Var.
		<hr/> 0
General Education		Units
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		<hr/> 18

Spring (Choose one project.)

Studio		Units
51-404	Senior Project: Interaction Design	12
51-406	Senior Project: Communication Design	12
51-408	Senior Project: Environmental Design	12
51-414	Integrated Product Development	12
		<hr/> 48
Ideas and Methods		Units
51-426	Beginning Book Arts Lab	9
51-452	Furniture Design II (II)	9
51-424	Web Portfolio	9
51-428	Time, Motion and Communication	9
		<hr/> 36

Design Studies		Units
51-472 /398	Globalization and Design	4.5
		<hr/> 4.5

Other

51-499	Senior Independent Study	Units Var.
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General Education

xx-xxx	Academic Elective	Units 9
xx-xxx	Free Elective	18

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 Carnegie Mellon University. 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.

DANIEL BOYARSKI, Professor of Design M.F.A., Indiana University School for Design, Kunstgewerbeschule, Basel, Switzerland; Carnegie Mellon, 1982.

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.

MARK MENTZER, Professor of Drawing B.F.A., Carnegie Mellon University; Carnegie Mellon, 1975.

THOMAS L. MERRIMAN, Teaching Professor in Design B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985.

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

LUIS 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

JOSEPH M. BALLAY, IDSA, Professor of Design, Emeritus M.F.A., Carnegie Mellon University; Carnegie Mellon, 1970-2002.

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 July 31, 2010 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 Undergraduate 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, metal working 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, introduction to accounting, cash budgeting, producing for television and film, camera lab, computer applications, technical management, organizational behavior, principles of economics, business communications and production management workshop. Stage and Production Managers 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.

Dramaturgy Option

Dramaturgy is the number-one growth field in the entertainment industry. Dramaturgs are theatre insiders who thrive on the process of being behind living theatre events. They love reading, writing, and thinking and believe in the power of theatre to enlighten, stimulate and entertain audiences. Through Carnegie Mellon University's new and innovative Dramaturgy Option you'll become an expert on historical practices and aesthetic theories behind any text, whether in production or waiting to come alive on stage. You will have the insights to reveal playwrights' intentions and the ability to communicate them to producers, directors, performers, and audiences.

The Dramaturgy adapts traditional, historical, and classic texts for the modern stage; aids directors, designers, and performers in clarifying their insights; collaborates with artistic directors in choosing exceptional repertory; finds social relevance in every work; links audiences with the ideas behind the productions in program notes, lectures, and talk-backs.

You will receive rigorous, highly structured academic and artistic training; broad and deep historical research; intensive study of aesthetic and critical theories; practical, professional-level experience in full scale theatre productions; opportunities to develop diversity by studying with Carnegie Mellon University professors in other arts as well as in the sciences and humanities; opportunities to study abroad; opportunities to work with professional companies in the US, Asia, Latin America, Africa, and Europe.

Your career possibilities include literary management; story editing for films and television; production dramaturgy; teaching: developing the talents and insights of students at educational institutions.

Theatre Studies Option

The Theatre Studies option offers students from any of the School's conservatory areas of specialized study the opportunity to continue developing their theatre related skills while expanding their interests to other artistic and academic areas. This option will only be available to Drama students that have completed their sophomore year in the School of Drama (ie: two years of conservatory training). Students are required to write a proposal outlining their interests in the Theatre Studies option, and the proposal must be approved by the Head of the School of Drama.

The goal of the Theatre Studies option is to enable students to explore the diverse opportunities for which conservatory drama training can be a basis, and to examine the possibility of post graduate education in a new area of specialization after obtaining a BFA in Drama. As the intent of the Theatre Studies option is to broaden your experiences, a semester studying abroad or participating in a recommended internship is required for one semester, either in the fall or spring.

Individualized courses of study are established for each student in consultation with the Theatre Studies option coordinator.

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		Units
54-011	Warmup	1
54-101	Acting I	10
54-103	Speech I	6
54-105	Voice/Alexander I	5
54-107	Movement I	4
54-159	Production Symposium I	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama I *	6
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

Spring		Units
54-012	Warmup	1
54-102	Acting I	10
54-104	Speech I	6
54-106	Voice/Alexander I	6
54-108	Movement I	4
54-160	Production Symposium I	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama I *	6
62-100	Critical Histories of the Art	9
xx-xxx	Non-Drama Elective	6-9

Sophomore Year

Fall		Units
54-201	Acting II	12
54-203	Voice and Speech II	5
54-207	Movement II	5
54-211	Actor Dance II	3
54-221	Directing II: Fundamentals	6
54-281	Foundations of Drama II ** or HSS Approved Course	6
xx-xxx	Non-Drama Elective	6-9
54-213	Singing for Actors II (Optional)	3

Spring		Units
54-202	Acting II	12
54-204	Voice and Speech II	6
54-208	Movement II	3
54-212	Actor Dance II	3
54-242	Improvisation	2
54-282	Foundations of Drama II ** or HSS Approved Course	6
54-294	Make-Up for Performers	2
xx-xxx	Non-Drama Elective	6-9
54-214	Singing for Actors II Optional	3

Junior Year

Fall		Units
54-301	Acting III	10
54-303	Speech III	6
54-305	Voice/Alexander III	5
54-307	Movement III	5
54-311	Acting Symposium III	16
54-325	Actor Dance III	2
54-381	History of Drama ***	6

54-409	Theatre Lab for Undergraduates	4
xx-xxx	Non-Drama Elective	6-9
54-317	Singing for Actors III (Optional)	3
54-xxx	Junior Auditioning (Optional)	2

Spring		Units
54-302	Acting III	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
54-381	History of Drama	6
54-410	Theatre Lab for Undergraduates	9
xx-xxx	Non-Drama Elective	6-9
54-318	Singing for Actors III (Optional)	3
54-xxx	Junior Auditioning (Optional)	2

Senior Year

Fall		Units
54-401	Camera Lab	3
54-405	Future Stages for Undergrad Actors	Var.
54-411	Acting Symposium IV	20
54-413	Showcase	4
54-437	Acting IV	5
54-493	Business of Acting	4
xxx-xxx	Non-Drama Elective	6-9
54-407	Movement IV (OR Non-Drama Physical Content Course 3-9 units)	4

Spring		Units
54-405	Future Stages for Undergrad Actors	Var.
54-412	Acting Symposium IV	20
54-414	Showcase	9
54-438	Acting IV	3
xx-xxx	Non-Drama Elective	6-9

NON-DRAMA ELECTIVES:

Actors 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 Actors will be required to take an approved H&SS course during the semester they are not taking Foundations of Drama II.

*** All Actors are required to complete 6 units of History of Drama during their junior year (two 3-unit minis, or one 6-unit full semester course.)

Music Theatre Option

Freshman Year

Fall		Units
54-101	Acting I	10
54-103	Speech I	6
54-105	Voice/Alexander I	5
54-107	Movement I	4
54-123	Ballet I	5
54-125	Music Skills I	2
54-159	Production Symposium I	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama I *	6
54-500	Voice Lab	5
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

Spring		Units
54-102	Acting I	10
54-104	Speech I	6
54-106	Voice/Alexander I	6
54-108	Movement I	4
54-124	Ballet I	5
54-126	Music Skills II	2
54-160	Production Symposium I	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama I *	6
54-500	Voice Lab	5
62-100	Critical Histories of the Art	9

Sophomore Year

Fall		Units
54-201	Acting II	12
54-203	Voice and Speech II	5
54-205	Ballet II	3
54-207	Movement II	3
54-217	Jazz II	2
54-219	Music Theatre Literature and Repertoire	4
54-223	Tap II	2
54-261	Production Symposium II ⁽⁺⁾	6
54-281	Foundations of Drama II ^{**} or HSS Approved Course	6
54-500	Voice Lab	5

Spring		Units
54-202	Acting II	12
54-204	Voice and Speech II	6
54-206	Ballet II	3
54-208	Movement II	3
54-218	Jazz II	2
54-224	Tap II	2
54-226	Acting a Song	4
54-262	Production Symposium II ⁽⁺⁾	6
54-281	Foundations of Drama II ^{**} or HSS Approved Course	6
54-294	Make-Up for Performers	2
54-500	Voice Lab	5

Junior Year

Fall		Units
54-301	Acting III	10
54-303	Speech III	6
54-305	Voice/Alexander III	5
54-311	Acting Symposium III	16
54-313	Ballet III	3
54-315	Jazz III	2
54-319	Cabaret	6
54-323	Tap III	2
54-381	History of Drama ^{***}	6
54-409	Theatre Lab for Undergraduates	Var.
54-500	Voice Lab	5

Spring		Units
54-302	Acting III	10
54-304	Speech III: Accents & Dialects	6
54-306	Voice/Alexander III	5
54-312	Acting Symposium III	16
54-314	Ballet III	3
54-316	Jazz III	2
54-324	Tap III	2
54-381	History of Drama ^{***}	6
54-410	Theatre Lab for Undergraduates	9
54-500	Voice Lab	5
xx-xxx	Non-Drama Elective	6-9

Senior Year

Fall		Units
54-401	Camera Lab	3
54-411	Acting Symposium IV	20
54-413	Showcase	4
54-415	Broadway Styles	4
54-423	Tap IV	2

54-437	Acting IV	5
54-493	Business of Acting	4
54-500	Voice Lab	5
54-407	Movement IV (Optional)	4

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 Music Theatre students will be required to take an approved HSS course during the semester they are not taking Foundations of Drama II.

***All Music Theatre students are required to complete 6 units of History of Drama during the junior year (two 3-unit minis, or one 6-unit full semester course).

****All Music Theatre students will be required to take one Non-Drama elective in the spring semester of Junior year.

+Production Symposium II is only taken one semester of the sophomore year.

Design Option

Freshman Year

Fall		Units
54-171	Basic Design	6
54-157	Basic PTM	6
54-151	Stagecraft	15
54-169	Studiocraft	13
54-175	Conservatory Hour	1
54-177	Foundations of Drama I	6
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

Spring		Units
54-172	Basic Design	6
54-158	Basic PTM	6
54-152	Stagecraft	11
54-170	Studiocraft	8
54-176	Conservatory Hour	1
54-178	Foundations of Drama I *	6
62-100	Critical Histories of the Art	9
xx-xxx	Non-Drama Elective	6-9

Sophomore Year

Fall - ALL DESIGN		Units
54-229	The Comfy Chair	6
54-231	Design for the Stage	6
54-271	Technical Management	5
54-249	Stagecraft II	14
54-269	Studiocraft II	3
54-221	Directing II: Fundamentals	Var.
54-210	Script Analysis	2
54-281	Foundations of Drama II ** or HSS Approved Course	6
xx-xxx	Non-Drama Elective	

Spring - ALL DESIGN		Units
54-260	Production Preparation II	12
54-282	Foundations of Drama II ** or HSS Approved Course	6
54-381	History of Drama ***	6
xx-xxx	Non-Drama Elective	6-9

Spring - SOUND DESIGN		Units
54-166	Introduction to Sound Design for Theatre	Var.
54-505	Ear Training	2
54-666	Production Audio	6

Spring - COSTUME DESIGN		Units
54-162	Intro to Costume Design	Var.
54-230	Make-up for Designers	6
54-346	Introduction to Costume Construction	Var.
54-348	Figure Drawing	6

Spring - SET DESIGN		Units
54-250	Intro to Scene Design	Var.
54-238	Scene Painting I	6
54-386	Scene Design Skills 3D	4

Spring - LIGHTING DESIGN		Units
54-252	Introduction to Lighting Design	Var.
54-270	Photoshop/Dreamweaver	3

Junior Year

Fall - ALL DESIGN		Units
54-239	History of Architecture and Decor	Var.
54-245	History of Clothing	Var.
54-361	Production Preparation III	Var.
54-381	History of Drama ***	6
xx-xxx	Non-Drama Elective	6-9

Fall - SOUND DESIGN		Units
54-267	Sound Design I	9
54-505	Ear Training	2
54-509	Advanced System Design	9

Fall - COSTUME DESIGN		Units
54-341	Costume Design I	9
54-343	Costume Construction I	Var.
54-347	Figure Drawing I	4
54-373	Drawing for Theatrical Designers	9
54-xxx	Costume Crafts	6

Fall - SET DESIGN		Units
54-237	Scene Painting I	6
54-331	Scene Design I	9
54-379	2-d Scene Design Skills	6

Fall - LIGHTING DESIGN		Units
54-351	Theatrical Lighting Design	9
54-367	Lighting Design Skills	2
54-368	Production Electrics	Var.
54-469	Dance Lighting Design	2
54-478	Television Lighting Design	1
54-xxx	New Lighting Design courses beginning Fall 2010	1-9

Spring - ALL DESIGN		Units
54-240	History of Architecture and Decor	Var.
54-246	History of Clothing	Var.
54-362	Production Preparation III	12
54-381	History of Drama ***	6
xx-xxx	Non-Drama Elective	6-9

Spring - SOUND DESIGN		Units
54-268	Sound Design I	Var.
54-505	Ear Training	2
54-509	Advanced System Design	9

Spring - COSTUME DESIGN		Units
54-342	Costume Design I	Var.
54-344	Costume Construction I	Var.
54-448	Figure Drawing II	6
54-450	Painting for the Theatrical Designer	6
54-xxx	Costume Crafts	6

Spring - SET DESIGN	Units
54-332 Scene Design I	Var.
54-238 Scene Painting I	6
54-270 Photoshop/Dreamweaver	3
54-386 Scene Design Skills 3D	4

Spring - LIGHTING DESIGN	Units
54-351 Theatrical Lighting Design	9
xx-xxx New Lighting Design courses beginning Fall 2010	1-9

Senior Year

Fall - ALL DESIGN	Units
54-461 Production Preparation IV	Var.
54-381 History of Drama ***	6
xx-xxx Non- Drama Elective	6-9

Fall - SOUND DESIGN	Units
54-397 Sound Design II	9
54-505 Ear Training	2

Fall - COSTUME DESIGN	Units
54-431 Scenography	Var.
or 54-441 Costume Design II (9 units)	
54-443 Costume Construction II	6
54-447 Figure Drawing II	4
54-373 Drawing for Theatrical Designers	9

Fall - SET DESIGN	Units
54-373 Drawing for Theatrical Designers	9
54-431 Scenography	Var.

Fall - LIGHTING DESIGN	Units
xx-xxx New Lighting Design courses beginning Fall 2010	1-9

Spring - ALL DESIGN	Units
54-462 Production Preparation IV	15
xx-xxx Non-Drama Elective	6-9
54-381 History of Drama ***	6

Spring - SOUND DESIGN	Units
54-398 Sound Design II	Var.
54-505 Ear Training	2

Spring - COSTUME DESIGN	Units
54-442 Costume Design II	Var.
54-444 Costume Construction II	Var.
54-450 Painting for the Theatrical Designer	6

Spring - SET DESIGN	Units
54-338 Advanced Scene Painting	6
54-450 Painting for the Theatrical Designer	6

Spring - LIGHTING DESIGN	Units
54-xxx New Lighting Design courses beginning Fall 2010	1-9

NON-DRAMA ELECTIVES:
Designers 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 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 History of Drama (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 History of Drama 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

Fall	Units
54-121 Directing I: Sources	9
54-517 Director's Colloquium	1
54-011 Warmup	1
54-101 Acting I	10
54-107 Movement I	4
54-159 Production Symposium I	6
54-175 Conservatory Hour	1
54-177 Foundations of Drama I *	6
76-101 Interpretation and Argument	9
xx-xxx Non-Drama Elective	6-9
99-101 Computing @ Carnegie Mellon	3

Spring	Units
54-122 Directing I: Sources	9
54-518 Director's Colloquium	1
54-012 Warmup	1
54-102 Acting I	10
54-108 Movement I	4
(with instructor permission)	
54-160 Production Symposium I	6
54-176 Conservatory Hour	1
54-177 Foundations of Drama I *	6
62-100 Critical Histories of the Art	9
xx-xxx Non-Drama Elective	6-9

Sophomore Year

Fall	Units
54-221 Directing II: Fundamentals	9
54-257 Directing: Production II	6
54-517 Director's Colloquium	1
54-201 Acting II	12
54-281 Foundations of Drama II **	6
(or HSS Approved Course)	
xx-xxx Non-Drama Elective	6-9
xx-xxx Non-Drama Elective	6-9
54-xxx Make-Up (Optional)	2

Spring	Units
54-222 Directing II: Fundamentals	9
54-258 Directing: Production II	6
54-518 Director's Colloquium	1
54-202 Acting II	12
54-330 Introduction to Stage Management	Var.
54-282 Foundations of Drama II **	6
(or HSS Approved Course)	
xx-xxx Non-Drama Elective	6-9

Junior Year

Fall	Units
54-357 Directing: Production III	12
54-517 Director's Colloquium	1
54-231 Design for the Stage	6
54-277 Stage Management I	6
54-321 Acting III for Directors	9
or 54-459 Future Stages for Undergrad Directors and Dramaturgs (6 units)	
54-381 History of Drama	6
xx-xxx Non-Drama Elective	6-9
54-239 History of Architecture and Decor	4
(Optional)	
54-245 History of Clothing	Var.
(Optional)	

Spring		Units
54-xxx	Tepper Internship Semester	36

Senior Year

Fall		Units
54-401	Camera Lab	3
54-409	Theatre Lab for Undergraduates	9
54-457	Directing: Production IV (~)	12
54-517	Director's Colloquium	1
54-381	History of Drama *** (if needed)	6
xx-xxx	Non-Drama Elective	6-9
xx-xxx	Non-Drama Elective	6-9
54-239	History of Architecture and Decor (Optional)	Var.
54-245	History of Clothing (Optional)	Var.

Spring		Units
54-410	Theatre Lab for Undergraduates	9
54-422	Directing IV	6
54-458	Directing: Production IV (~)	10
54-518	Director's Colloquium	1
54-xxx	TV Project	3
xx-xxx	Non-Drama Elective	6-9
xx-xxx	Non-Drama Elective	6-9
54-381	History of Drama *** (if needed)	6

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. Sophomore 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 History of Drama 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.

Production Technology and Management (PTM) Option

Freshman Year

Fall		Units
54-151	Stagecraft	15
54-157	Basic PTM	6
54-169	Studiocraft	13
54-171	Basic Design	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama I *	6
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

Spring		Units
54-152	Stagecraft	11
54-158	Basic PTM	6
54-170	Studiocraft	8
54-172	Basic Design	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama I *	6
62-100	Critical Histories of the Art	9
xx-xxx	Non-Drama Elective	6-9

Sophomore Year

Fall		Units
54-229	The Comfy Chair	6
54-231	Design for the Stage	6
54-271	Technical Management	5
54-249	Stagecraft II	14
54-269	Studiocraft II	3
54-221	Directing II: Fundamentals	6
54-210	Script Analysis	2
54-281	Foundations of Drama II ** (or HSS Approved Course)	6
xx-xxx	Non-Drama Elective	6-9

Spring - ALL PTM		Units
54-260	Production Preparation II	12
54-272	Scenic Fabrication and Installation	6-18
54-330	Introduction to Stage Management	6-18
54-334	Production Resource Management	6-18
54-282	Foundations of Drama II ** (or HSS Approved Course)	6
xx-xxx	Directed Elective	3-12
xx-xxx	Non-Drama Elective	6-9

Spring - PTM TECHNICAL DIRECTION		Units
54-264	Welding	4

Spring - PTM PRODUCTION/STAGE MANAGEMENT (PM/SM)		Units
54-166	Introduction to Sound Design for Theatre	Var.

Junior Year

Fall - ALL PTM		Units
54-273	Technical Direction I	6
54-333	Production Personnel Management	6
54-361	Production Preparation III	Var.
54-381	History of Drama ***	6
xx-xxx	Directed Elective	3-12
xx-xxx	Non-Drama Elective	6-9

Fall - PTM TECHNICAL DIRECTION		Units
54-353	Structural Design I (~)	9
	or 54-366 Physics of Stage Machinery (9 units)	

Fall - PTM PM/SM		Units
54-277	Stage Management I	6
54-339	Stage Management Seminar	3

Spring - ALL PTM		Units
54-475	Theatre Management	6
54-362	Production Preparation III	12
54-381	History of Drama ***	6
xx-xxx	Directed Elective	3-12
xx-xxx	Non-Drama Elective	6-9

Spring - PTM TECHNICAL DIRECTION		Units
54-354	Structural Design II (~)	9
	or 54-365 Machine Design I (9 units)	
54-378	Technical Design I	9
54-376	Entertainment Rigging	6

Spring - PTM PM/SM	Units
54-278 Stage Management I	6-21
54-340 Stage Management Seminar	3
54-456 Production Management Workshop	3-18
54-380 Music Reading for Drama Technicians	3

Senior Year

Fall - ALL PTM	Units
54-355 30 Hour Osha	6
54-461 Production Preparation IV	Var.
xx-xxx Directed Elective	3-12
xx-xxx Non-Drama Elective	6-12
54-381 History of Drama ***	6

Fall - PTM TECHNICAL DIRECTION	Units
54-477 Technical Direction III	6
54-353 Structural Design I (~)	9
or 54-366 Physics of Stage Machinery (9 units)	

Fall - PTM PM/SM	Units
54-359 Stage Management II	6
54-439 Stage Management Seminar	3
54-453 Production Management Workshop I	3

Spring - ALL PTM	Units
54-462 Production Preparation IV	15
54-464 PTM Business Practices	3
xx-xxx Non-Drama Elective	6-12
54-381 History of Drama ***	6

Spring - PTM TECHNICAL DIRECTION	Units
54-354 Structural Design II	9
or 54-466 Machine Design II (9 units)	
54-466 Machine Design II	9
54-480 Technical Direction IV	Var.

Spring - PTM PM/SM	Units
54-356 Stage Management II	6
54-440 Stage Management Seminar	Var.
54-456 Production Management Workshop	Var.
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 History of Drama (two 3-unit minis, or one 6-unit full semester course).
- ~ Classes offered in alternating years.

Dramaturgy Option

Freshman Year

Fall	Units
54-177 Foundations of Drama I	6
54-109 Dramaturgy I: 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 *	9-12
xx-xxx Directed Elective	9
99-101 Computing @ Carnegie Mellon	3

Spring	Units
54-178 Foundations of Drama I	6
54-184 Dramaturgy 2: History and Practice	Var.
54-160 Production Symposium I	6
54-176 Conservatory Hour	1
62-100 Critical Histories of the Art	9
82-xxx Modern Language *	9-12
xx-xxx Directed Elective	
xx-xxx Non-Dramaturgy Elective	6-9

Sophomore Year

Fall	Units
54-xxx Dramaturgy 3/4/5/6 **	9
54-299 Dramaturgy Production I	Var.
54-200 Ghost Light Forum	1
54-239 History of Architecture and Decor	Var.
54-245 History of Clothing	Var.
76-xxx Directed English theory course	9
xx-xxx Directed Elective	9
xx-xxx Non-Dramaturgy Elective	6-9

Spring	Units
54-xxx Dramaturgy 3/4/5/6 **	9
54-xxx Intro Design course (field of choice)	9
54-200 Ghost Light Forum	1
54-299 Dramaturgy Production I	Var.
xx-xxx Directed Elective	9
xx-xxx Directed Elective	9
xx-xxx Directed Elective	
xx-xxx Non-Dramaturgy Elective	6-9

Junior Year

Fall	Units
54-xxx Dramaturgy 3/4/5/6 ***	9
54-387 Dramaturgy : Production II	Var.
54-200 Ghost Light Forum	1
54-381 History of Drama ***	6
54-463 Dramaturgy Research Hours	Var.
xx-xxx Directed Elective	9
xx-xxx Non-Dramaturgy Elective	6-9

Spring	Units
54-xxx Dramaturgy 3/4/5/6	9
54-388 Dramaturgy: Production III	Var.
54-381 History of Drama ***	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		Units
54-xxx	Dramaturgy 3/4/5/6 **	9
54-487	Dramaturgy: Production III	Var.
54-200	Ghost Light Forum	1
54-381	History of Drama ***	6
54-463	Dramaturgy Research Hours	Var.
54-489	Dramaturgy: Internship (~)	9
xxx-xxx	Directed Elective	9
xx-xxx	Non-Dramaturgy Elective	6-9

Spring		Units
54-xxx	Dramaturgy 3/4/5/6 **	9
54-200	Ghost Light Forum	1
54-381	History of Drama ***	6
54-463	Dramaturgy Research Hours	Var.
54-488	Dramaturgy: Production III	Var.
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: Postmodern Am/Brit Fiction and Film		9
76-431 Chaucer		9
76-432 Advanced Seminar in African American Studies: Ralph Ellison		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 II: Fundamentals		Var.

NON-DRAMATURGY ELECTIVES:
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 History of Drama during their junior and senior year (3-unit minis 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, Interim Head, School of Drama, Associate Teaching Professor of Design M.F.A., Northwestern University; Carnegie Mellon, 1988.
- DAVID BOEVERS, Assistant Professor, Production Technology and Management, Option Coordinator, PTM M.F.A., Yale University; Carnegie Mellon, 2000.
- JAMES CATON, Associate Teaching Professor, Dance Carnegie Mellon, 1988.
- MICHAEL CHEMERS, Assistant Professor, Dramaturgy Ph.D., University of Washington; Carnegie Mellon, 2004.
- JUDITH CONTE, Associate Teaching Professor, Dance B.F.A., University of Wisconsin/ Milwaukee; Carnegie Mellon, 1978.
- THOMAS DOUGLAS, Associate Teaching Professor, Music Theatre M.M., Duquesne University; Carnegie Mellon, 1991.
- JANET MADELLE FEINDEL, Associate Professor, Voice/Alexander M.F.A., Carnegie Mellon; Carnegie Mellon, 1996.
- MATTHEW GRAY, Assistant Professor, Acting B.F.A., University of British Columbia; London Academy of Music and Dramatic Arts; Carnegie Mellon, 2005.
- ROB HANDEL, M.F.A., Brown University; Carnegie Mellon, 2009.
- JED ALLEN HARRIS, Associate Teaching Professor, Directing M.F.A., Carnegie Mellon; Carnegie Mellon, 1991.
- KEVIN HINES, Associate Teaching Professor, Production Technology & Management M.F.A., Yale University; Carnegie Mellon, 1998.
- ABIGAIL ROSEN HOLMES, B.F.A., Brown University; Carnegie Mellon, 2008-.
- GARY KLINE, Associate Teaching Professor, Music Theatre B.F.A., Carnegie Mellon; Carnegie Mellon, 1990.
- GREGORY LEHANE, Professor, Directing M.F.A., Carnegie Mellon; Carnegie Mellon, 1991.
- CINDY LIMAURO, Professor, Lighting Design M.F.A., Florida State; Carnegie Mellon, 1987.
- BARBARA MACKENZIE WOOD, Professor, Acting; Option Coordinator, Acting/MT M.F.A., Carnegie Mellon; Carnegie Mellon, 1986.
- ANTHONY MCKAY, Associate Professor, Acting B.F.A., Carnegie Mellon; Carnegie Mellon, 1985.
- CATHERINE MOORE, Associate Teaching Professor, Movement M.F.A., University of Cincinnati, College-Conservatory of Music; Carnegie Mellon, 2000.
- ANNE MUNDELL, Associate Professor, Design; Option Coordinator, Design M.F.A., Brandeis University; Carnegie Mellon, 1989.
- JOE PINO, Assistant Professor, Sound Design M.F.A., University of Virginia; Carnegie Mellon, 1999.
- BRIAN RUSSMAN, Carnegie Mellon, 2009.
- TINA SHACKLEFORD, Associate Teaching Professor, Stage Management M.F.A., University of California, San Diego; Carnegie Mellon, 2004.
- LARRY SHEA, M.F.A., Massachusetts College of Art; Carnegie Mellon, 2010.
- NARELLE SISSONS, Assistant Professor, Design M.A., Central/St Martin's and The Royal College of Art in London, UK; Carnegie Mellon, 2007.

INGRID SONNICHSEN, Associate Teaching Professor, Acting M.A.,
Wayne State University; Carnegie Mellon, 1995.

SUSAN TSU, Professor, Costume Design M.F.A., Carnegie Mellon,
2003.

DON WADSWORTH, Professor, Voice & Speech M.F.A., University of
Pittsburgh; Carnegie Mellon, 1989.

KAF WARMAN, Associate Teaching Professor, Movement M.F.A.,
Goddard College, Ecole; Carnegie Mellon, 1996.

MARIANNE WEEMS, B.A., Barnard College; Carnegie Mellon, 2009.

School of Music

Noel Zahler, Head
Office: The College of Fine Arts 105

The School of Music at Carnegie Mellon employs the best aspects of conservatory training set within a great university, combining preparation for a lifetime in performance or composition with the advantages of learning in an intense academic environment. The School of Music is an accredited institutional member of the National Association of Schools of Music.

Each student is challenged to develop as a performer through individual instruction with master teachers. The School's relationship with the renowned Pittsburgh Symphony is among the strongest conservatory-symphony orchestra relationships in the United States, and Pittsburgh's uniquely strong sense of musical community fosters close relationships with the Pittsburgh Opera, Opera Theater of Pittsburgh, Pittsburgh Chamber Music Society, Pittsburgh Ballet Theatre, Mendelssohn Choir, and a host of other professional musical organizations. All teaching is entrusted to professional faculty — there are no assistant studio teachers or doctoral teaching fellows — and specialists in Musicology, Theory, Counterpoint, Analysis, Composition, Computer Music, Eurhythmics, Solfege, Music Education, Pedagogy, Accompanying and Coaching, Acting and Movement, Diction, Literature and Repertoire, Baroque Music, Chamber Music, Jazz, Conducting, and Recording Science provide a broad and rich platform for comprehensive performance preparation.

Regular performing ensembles include the Carnegie Mellon Philharmonic, Wind Ensemble, Concert Choir, Repertory Chorus, Baroque Ensemble, Contemporary Ensemble, Jazz Ensemble, Jazz Vocal Ensemble, Repertoire Orchestra, and Opera/Music Theater Production. Some of the School's ensembles are instrument specific: Chamber Music ensembles and the Percussion Ensemble, among others.

Every student in the School of Music is a performance or composition major. Opportunities for performance are stressed undergraduate performance majors perform junior and senior recitals, chamber music is publicly presented, frequent opportunities on and off campus are provided, and community outreach is vigorously supported. At the same time, the university provides the greatest possible support for students combining their majors with minors in all disciplines, unique joint degree programs, 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 has an intense commitment to new music, led by its composition faculty, conductors who devote fully rehearsed cycles of the Philharmonic to works by student composers, studio faculty whose own performing careers regularly feature new works, regular performances of student works in almost every Contemporary Ensemble Program, frequent opportunities with the Wind Ensemble and Choirs, and inclusion on student recitals. The School's state-of-the-art recording facilities are an especially important resource for composers beginning their public careers.

Facilities

The teaching facilities of the School of Music are located on the ground, 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

The School of Music offers a Bachelor of Fine Arts in the following areas:

- 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
- Music Technology Minor

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.

Piano Pedagogy Certificate

A two-year program leading to certification in piano pedagogy is open to current Carnegie Mellon piano majors and to pianists with bachelor's degrees. Piano and organ majors learn to teach piano in a closely supervised environment of class piano instruction. This program has received national acclaim as a model of excellence, with Carnegie Mellon children consistently capturing prestigious awards in national piano competitions.

Accompanying Minor

The accompanying minor consists of a six-semester sequence of courses designed to give the students experience with vocalists and instrumentalists. There are individual coaching sessions as well as practical experience in vocal and instrumental studios.

Conducting Minor

This program is designed for students who are interested in acquiring conducting skills, in anticipation of either graduate study in conducting or a music education career. It includes required courses in basic conducting techniques for both choral and instrumental ensembles, orchestration, score reading/keyboard harmony, and elective courses in instrumental and vocal methods, diction, and literature and repertoire.

Music Education Certification Minor

Music Education Certification is a five-year program, with courses starting in the sophomore year. Bachelor of Fine Arts candidates who complete this program and pass the Praxis tests will receive Pennsylvania state certification in music (K-12), which is recognized in almost all other states.

Music Technology Minor

The student will take a series of courses which may include electronic and computer music, recording technology, the physics of sound, and computer programming. A rich computer music research environment enables talented students to work as programmers with outstanding faculty researchers, whose current projects are gaining international recognition in the areas of computer music and artificial intelligence.

Performances and Activities of the School of Music

The School of Music sponsors performances, master classes, and lectures by outstanding national and international guest artists. Announcements of faculty, student, and guest performances are released every month to the students and the community.

General Requirements for BFA Candidates

Candidates for the Bachelor of Fine Arts degree in composition are required to complete a composition for orchestra in their senior year.

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 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
2. Theory
3. History
4. Ensemble
5. Academics

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, Opera/Music Theater 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 399 for voice majors; 384 for composition majors; 372 for instrumental, organ, and piano majors. Three units equal one credit.

Piano

First Year

	Units
Fall	
57-100 Convocation	0
57-501 Major Studio (Piano)	9
57-4xx Major Ensemble	6
57-193 Skills of Accompanying I	3
57-152 Harmony I	9
57-161 Eurhythmics I	3
57-181 Solfege I	3
57-189 Repertoire and Listening for Musicians I	3
57-173 Survey of Western Music History	9
76-101 Interpretation and Argument	9
	54
Spring	
57-100 Convocation	0
57-501 Major Studio (Piano)	9
57-4xx Major Ensemble	6
57-194 Skills of Accompanying II	3
57-153 Harmony II	9
57-162 Eurhythmics II	3
57-182 Solfege II	3

57-190	Repertoire and Listening for Musicians II	3
62-100	Critical Histories of the Art	9
57-101	Introduction to Music Technology	6
99-10x	Computing @ Carnegie Mellon	3
		54

Second Year

	Units
Fall	
57-100 Convocation	0
57-501 Major Studio (Piano)	9
57-4xx Major Ensemble	6
57-228 Chamber Music	3
57-408 Form and Analysis	6
57-163 Eurhythmics III	3
57-183 Solfege III	3
57-289 Repertoire and Listening for Musicians III	3
57-283 Music History I	9
xx-xxx General Studies Course	6
	48

Spring		
57-100 Convocation	0	
57-501 Major Studio (Piano)	9	
57-4xx Major Ensemble	6	
57-228 Chamber Music	3	
57-151 Concept and Practice of Counterpoint	6	
57-164 Eurhythmics IV	3	
57-184 Solfege IV	3	
57-290 Repertoire and Listening for Musicians IV	3	
57-284 Music History II	9	
xx-xxx Elective	6	
		48

Third Year

	Units
Fall	
57-100 Convocation	0
57-501 Major Studio (Piano)	9
57-4xx Major Ensemble	6
57-228 Chamber Music	3
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	6
	45

Spring		
57-100 Convocation	0	
57-501 Major Studio (Piano)	9	
57-4xx Major Ensemble	6	
57-228 Chamber Music	3	
57-xxx Music Support Course (Theory/History)	12	
xx-xxx General Studies Course	9	
xx-xxx Elective	6	
		45

Fourth Year

	Units
Fall	
57-100 Convocation	0
57-501 Major Studio (Piano)	9
57-xxx Performance Elective	9
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	3
	42

Spring		
57-100 Convocation	0	
57-501 Major Studio (Piano)	9	
57-xxx Performance Elective	9	
57-xxx Music Support Course (Theory/History)	12	
xx-xxx General Studies Course	9	
xx-xxx Elective	3	
		42

**Organ
First Year**

	Units
Fall	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-152 Harmony I	9
57-161 Eurhythmics I	3
57-181 Solfege I	3
57-189 Repertoire and Listening for Musicians I	3
57-173 Survey of Western Music History	9
76-101 Interpretation and Argument	9
	54

Spring	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-153 Harmony II	9
57-162 Eurhythmics II	3
57-182 Solfege II	3
57-190 Repertoire and Listening for Musicians II	3
62-100 Critical Histories of the Art	9
57-101 Introduction to Music Technology	6
99-10x Computing @ Carnegie Mellon	3
	54

Second Year

	Units
Fall	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-408 Form and Analysis	6
57-163 Eurhythmics III	3
57-183 Solfege III	3
57-289 Repertoire and Listening for Musicians III	3
57-283 Music History I	9
xx-xxx General Studies Course	6
	48

Spring	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-151 Concept and Practice of Counterpoint	6
57-164 Eurhythmics IV	3
57-184 Solfege IV	3
57-290 Repertoire and Listening for Musicians IV	3
57-284 Music History II	9
xx-xxx Elective	6
	48

Third Year

	Units
Fall	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-459 Score Reading/Keyboard Harmony	6
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	3
	45

Spring	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	9
	45

Fourth Year

	Units
Fall	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-xxx Performance Elective	3
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	3
	42

Spring	
57-100 Convocation	0
57-502 Major Studio (Organ)	9
57-4xx Major Ensemble	6
57-xxx Performance Elective	3
57-xxx Music Support Course (Theory/History)	12
xx-xxx General Studies Course	9
xx-xxx Elective	3
	42

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.

First Year

	Units
Fall	
57-100 Convocation	0
57-500 Major Studio (Voice)	9
57-417 Major Choral Ensemble	6
57-191 Keyboard Studies	3
57-152 Harmony I	9
57-161 Eurhythmics I	3
57-181 Solfege I	3
57-221 Italian Diction	3
57-240 Acting I	6
57-111 Movement and Dance I	3
82-161 Elementary Italian I	12
	57

Spring	
57-100 Convocation	0
57-500 Major Studio (Voice)	9
57-417 Major Choral Ensemble	6
57-191 Keyboard Studies	3
57-153 Harmony II	9
57-162 Eurhythmics II	3
57-182 Solfege II	3
57-431 Italian Literature and Repertoire	3
57-241 Acting II	6
57-112 Movement and Dance II	3
76-101 Interpretation and Argument	9
99-10x Computing @ Carnegie Mellon	3
	57

Second Year

	Units
Fall	
57-100 Convocation	0
57-500 Major Studio (Voice)	9
57-417 Major Choral Ensemble	6
57-191 Keyboard Studies	3
57-163 Eurhythmics III	3
57-183 Solfege III	3
57-189 Repertoire and Listening for Musicians I	3
57-173 Survey of Western Music History	9
82-121 Elementary German I	12
57-223 German Diction	3
57-339 Acting III	6
57-211 Movement and Dance III	3
	60

Spring	
57-100 Convocation	0
57-500 Major Studio (Voice)	9
57-417 Major Choral Ensemble	6
57-191 Keyboard Studies	3
57-164 Eurhythmics IV	3
57-184 Solfege IV	3
57-190 Repertoire and Listening for Musicians II	3

62-100	Critical Histories of the Art	9
57-435	German Literature and Repertoire	3
57-340	Acting IV	6
57-212	Movement and Dance IV	3
57-101	Introduction to Music Technology	6
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		54

Third Year

Fall		Units
57-100	Convocation	0
57-500	Major Studio (Voice)	9
57-417	Major Choral Ensemble	6
57-xxx	Production Course	6
57-408	Form and Analysis	6
57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
82-101	Elementary French I	12
57-222	French Diction	3
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		54

Spring		
57-100	Convocation	0
57-500	Major Studio (Voice)	9
57-417	Major Choral Ensemble	6
57-xxx	Production Course	6
57-151	Concept and Practice of Counterpoint	6
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
57-432	French Literature and Repertoire	3
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		42

Fourth Year

Fall		Units
57-100	Convocation	0
57-500	Major Studio (Voice)	9
57-417	Major Choral Ensemble	6
57-xxx	Production Course	6
57-220	English Diction	3
57-434	Musical Theatre Literature and Repertoire	3
xx-xxx	Elective	6
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		33

Spring		
57-100	Convocation	0
57-500	Major Studio (Voice)	9
57-417	Major Choral Ensemble	6
57-xxx	Production Course	6
57-436	English/Contemporary Literature and Repertoire	3
57-434	Musical Theatre Literature and Repertoire	3
xx-xxx	Elective	6
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		33

Instrumental

First Year

Fall		Units
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-418	Major Instrumental Ensemble	6
57-191	Keyboard Studies	3
57-152	Harmony I	9
57-161	Eurhythmics I	3
57-181	Solfege I	3
57-189	Repertoire and Listening for Musicians I	3
57-173	Survey of Western Music History	9
76-101	Interpretation and Argument	9
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		60

Spring		
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies	3
57-153	Harmony II	9
57-162	Eurhythmics II	3
57-182	Solfege II	3

57-190	Repertoire and Listening for Musicians II	3
62-100	Critical Histories of the Art	9
57-101	Introduction to Music Technology	6
99-10x	Computing @ Carnegie Mellon	3
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		54

Second Year

Fall		Units
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies	3
57-408	Form and Analysis	6
57-163	Eurhythmics III	3
57-183	Solfege III	3
57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
xx-xxx	General Studies Course	6
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		48

Spring		
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies	3
57-151	Concept and Practice of Counterpoint	6
57-164	Eurhythmics IV	3
57-184	Solfege IV	3
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
xx-xxx	Elective	6
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		48

Third Year

Fall		Units
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	General Studies Course	9
xx-xxx	Elective	6
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		45

Spring		
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	General Studies Course	9
xx-xxx	Elective	6
		<hr/>
		45

Fourth Year

Fall		Units
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	General Studies Course	9
xx-xxx	Elective	3
		<hr/>
		42

Spring		
57-100	Convocation	0
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	General Studies Course	9
xx-xxx	Elective	3
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		42

Composition

Freshman Year

	Units
Fall	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-152 Harmony I	9
57-162 Eurhythmics II	3
57-181 Solfege I	3
57-189 Repertoire and Listening for Musicians I	3
57-173 Survey of Western Music History	9
57-101 Introduction to Music Technology	6
99-10x Computing @ Carnegie Mellon	3
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Spring	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-153 Harmony II	9
57-162 Eurhythmics II	3
57-182 Solfege II	3
57-190 Repertoire and Listening for Musicians II	3
62-100 Critical Histories of the Art	9
76-101 Interpretation and Argument	9
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Sophomore Year

	Units
Fall	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-408 Form and Analysis	6
57-163 Eurhythmics III	3
57-183 Solfege III	3
57-289 Repertoire and Listening for Musicians III	3
57-283 Music History I	9
57-257 Orchestration I	6
xx-xxx Elective	6
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	54

Spring	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-191 Keyboard Studies	3
57-151 Concept and Practice of Counterpoint	6
57-164 Eurhythmics IV	3
57-184 Solfege IV	3
57-290 Repertoire and Listening for Musicians IV	3
57-284 Music History II	9
57-271 Orchestration II	6
57-258 20th-21st Century Techniques	6
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Junior Year

	Units
Fall	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-234 Performance for Composers	3
57-332 Introduction to Conducting	6
57-347 Electronic and Computer Music	6
57-xxx Music Support Course ⁽¹⁾	6
xx-xxx General Studies Course	9
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Spring	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-236 Performance for Composers	3
57-336 Instrumental/Choral Conducting	6
57-459 Score Reading/Keyboard Harmony	6
57-xxx Music Support Course ⁽²⁾	6
xx-xxx General Studies Course	9
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	39

Senior Year

	Units
Fall	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-xxx Music Support Course ⁽²⁾	6
xx-xxx General Studies Course	9
xx-xxx Elective	12
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	42

Spring	
57-100 Convocation	0
57-521 Major Studio (Composition)	9
57-4xx Major Ensemble	6
57-349 Supervised Theory Teaching	6
57-xxx Music Support Course ⁽²⁾	6
xx-xxx General Studies Course	9
xx-xxx Elective	6
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	42

Notes:

¹ One music support course is recommended to be Creative Orchestration.

² One music support course must be an analysis course.

Additional Requirements

- Repertoire Proficiency I
- Repertoire Proficiency II
- Repertoire Proficiency III
- Repertoire Proficiency IV
- Piano Proficiency
- Senior Project

Dalcroze Eurhythmics Certificate 30 units

57-465 Eurhythmics Applications for Performing and Teaching	6
57-466 Eurhythmics Applications for Performing and Teaching	6
57-691 /692 Dalcroze Pedagogy/Practice Teaching	6
57-350 Dalcroze Piano Improvisation	6
xx-xxx Creative Movement/Choreography	3
57-641 /642 Dalcroze Research Paper	3

Piano Pedagogy Certificate 30 units

57-273 Piano Pedagogy I	6
57-274 Piano Pedagogy II	6
57-275 Piano Pedagogy III	6
57-276 Piano Pedagogy IV	6
57-429 Beginning Piano for Children	6

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

Seminar

57-57x Music and Technology Course (8 semesters) 12

University

99-10x Computing @ Carnegie Mellon 3
 76-101 Interpretation and Argument 9
 79-104 Global Histories 9

Humanities

xx-xxx Cognition, Choice and Behavior course 9
 xx-xxx English, History, Modern Languages, Philosophy, or Psychology course 9

Mathematics

21-120 Differential and Integral Calculus 10
 21-122 Integration, Differential Equations and Approximation 10

OR:

21-115 Differential Calculus (AP) 5
 21-121 Integration and Differential Equations 10
 21-123 Calculus of Approximation 5

Science

33-114 Physics of Musical Sound 9
 33-106 Physics I for Engineering Students 12

Electives 29 units

Music Core 104 units

57-100 Convocation (8 semesters) 0
 57-152 Harmony I 9
 57-153 Harmony II 9
 57-408 Form and Analysis 6
 57-151 Concept and Practice of Counterpoint 6
 57-258 20th-21st Century Techniques 6
 57-257 Orchestration I 6
 57-271 Orchestration II 6
 57-189 Repertoire and Listening for Musicians I 3
 57-190 Repertoire and Listening for Musicians II 3
 57-289 Repertoire and Listening for Musicians III 3
 57-290 Repertoire and Listening for Musicians IV 3
 57-181 Solfege I 3
 57-182 Solfege II 3
 57-183 Solfege III 3
 57-184 Solfege IV 3
 57-161 Eurhythmics I 3
 57-162 Eurhythmics II 3
 57-283 Music History I 9
 57-284 Music History II 9

Music and Technology Core 121 units

15-110 Principles of Computing 10
 or 15-121 Introduction to Data Structures (10 units)
 15-123 Effective Programming in C and UNIX 9
 15-322 Introduction to Computer Music 9
 18-100 Introduction to Electrical and Computer Engineering 12
 18-202 Mathematical Foundations of Electrical Engineering 12
 18-290 Signals and Systems 12
 57-101 Introduction to Music Technology 6
 57-347 Electronic and Computer Music 6

57-337 Sound Recording 6
 57-338 Sound Editing and Mastering 6
 57-438 Multitrack Recording 9
 57-57x Music and Technology Course 12
 57-57x Music and Technology Course 12

Students complete either the Music Concentration or the Technical Concentration:

Music Concentration 60 units

57-5xx Studio (4 semesters) 36
 57-4xx Major Ensemble (4 semesters) 24

Technical Concentration 57 or 55 units

21-127 Concepts of Mathematics 9
 15-213 /18-243 Introduction to Computer Systems 12

AND EITHER:

18-220 Electronic Devices and Analog Circuits 12
 18-240 Structure and Design of Digital Systems 12
 15-2xx /18-3xx Electives in ECE or CS or above 12

OR:

15-128 Freshman Immigration Course 1
 15-211 Fundamental Data Structures and Algorithms 12
 15-323 Computer Music Systems and Information Processing 9
 15-2xx /18-3xx Electives in ECE or CS or above 12

Total number of units required for major	394
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Minor in Accompanying for Piano Majors 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).

Required Courses 36 units

57-381 Accompanying I 6
 57-382 Accompanying II 6
 57-383 Accompanying III 6
 57-384 Accompanying IV 6
 57-385 Accompanying V 6
 57-386 Accompanying VI 6

Electives 18 units

(choose from the following courses)

57-220 English Diction 3
 57-221 Italian Diction 3
 57-222 French Diction 3
 57-223 German Diction 3
 57-332 Introduction to Conducting 6
 57-336 Instrumental/Choral Conducting 6
 57-431 Italian Literature and Repertoire 3
 57-432 French Literature and Repertoire 3
 57-433 Musical Theatre Literature and Repertoire 3
 57-434 Musical Theatre Literature and Repertoire 3
 57-435 German Literature and Repertoire 3
 57-436 English/Contemporary Literature and Repertoire 3
 57-459 Score Reading/Keyboard Harmony 6
 57-607 Vocal Methods 3

Minimum units required for Accompanying Minor: 54

Minor in Conducting 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) and have an interview with a member of the conducting faculty.
2. A 3.0 cumulative overall QPA and good academic standing are required for acceptance into the minor in conducting. Note that only a limited number of students can be accepted into the program.
3. In addition to the prerequisite courses listed below, the student must display superior solfege skills, by completing Advanced Solfege I and II with A or B grades or by demonstrating the equivalent level of skills.
4. Introduction to Conducting and Instrumental/Choral Conducting must be completed during the sophomore year with A grades before the student can register for the advanced conducting courses.
5. Conducting Practicum must be taken during the same semester as Independent Study in Conducting.
6. A 3.0 cumulative overall QPA is required for graduation with the minor in conducting.

Prerequisite Courses	39 units
57-152 Harmony I	9
57-153 Harmony II	9
57-161 Eurhythmics I	3
57-162 Eurhythmics II	3
57-173 Survey of Western Music History	9
57-189 Repertoire and Listening for Musicians I	3
57-191 Keyboard Studies	3

Corequisite Course for Voice Majors	6 units
57-151 Concept and Practice of Counterpoint	6

Required Courses	45 units
57-332 Introduction to Conducting	6
57-336 Instrumental/Choral Conducting	6
57-408 Form and Analysis	6
57-257 Orchestration I	6
57-271 Orchestration II	6
57-459 Score Reading/Keyboard Harmony	6
57-364 Conducting Practicum	3
57-618 Independent Study in Conducting	6

Electives 12 units

(choose from the following courses)

57-220 English Diction	3
57-221 Italian Diction	3
57-222 French Diction	3
57-223 German Diction	3
57-258 20th-21st Century Techniques	6
57-337 Sound Recording	6
57-338 Sound Editing and Mastering	6
57-360 Brass Methods	3
57-361 Percussion Methods	3
57-363 String Methods	3
57-362 Woodwind Methods	3
57-431 Italian Literature and Repertoire	3
57-432 French Literature and Repertoire	3
57-435 German Literature and Repertoire	3
57-607 Vocal Methods	3
57-227 Jazz Ensemble	3
57-228 Chamber Music	3

Minimum units required for Conducting minor: 57

Minor in Music Education for Students in the School of Music

Admission Requirements:

The student should apply to the music education faculty no earlier than spring of the freshman year.

Corequisite General Courses	45 units
21-xxx Mathematics Course #1	9
21-xxx Mathematics Course #2	9
76-xxx English Literature Course	9
85-xxx Developmental Psychology Course	9
85-xxx Educational Psychology Course	9

Corequisite Music Courses	18 units
57-391 Keyboard Studies (Music Ed)	3
57-392 Keyboard Studies (Music Ed)	3
57-393 Keyboard Studies Test (Music Ed)	0
57-332 Introduction to Conducting	6
57-336 Instrumental/Choral Conducting	6

General Education Courses	18 units
57-331 Principles of Education	9
xx-xxx Professional Education Course	9

Music Education Methods Courses 45 units

General Methods Courses

57-375 Music in the Elementary School	6
57-356 Elementary Guided Teaching	3
57-376 Music in the Secondary School	6
57-355 Secondary Guided Teaching	3

Applied Area Methods Courses

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
57-331 Principles of Education	9

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: 78

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 Course 3 units

Computing @ Carnegie Mellon must be passed before taking any of the required technology courses.

99-10x Computing @ Carnegie Mellon 3

Introductory Music Courses 21 units

57-152 Harmony I 9
57-173 Survey of Western Music History 9
57-189 Repertoire and Listening for Musicians I 3

Required Music Technology Courses 33 units

57-101 Introduction to Music Technology 6
57-337 Sound Recording 6
57-338 Sound Editing and Mastering 6
57-347 Electronic and Computer Music 6
57-438 Multitrack Recording 9

Technical Courses (Choose 2) 15 units

Other technical courses may also be approved by special permission.

15-110 Principles of Computing 10
15-323 Computer Music Systems and Information Processing 9
33-114 Physics of Musical Sound 9
54-509 Advanced System Design 9
54-666 Production Audio 6
57-610 Internship Var.

Minimum units required for Music Technology Minor: 69

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).

2. The student must perform an acceptable audition. Requirements for the audition can be found in the Admission section of the Undergraduate Catalog.

Corequisite Courses 27 units

57-161 Eurhythmics I 3
57-181 Solfege I 3
57-152 Harmony I 9
57-173 Survey of Western Music History 9
57-189 Repertoire and Listening for Musicians I 3

Required Studio Courses 24 units

57-496 Minor Studio 6
57-497 Minor Studio 6
57-498 Minor Studio 6
57-499 Minor Studio 6

Required Language Courses (Voice Minors) 18 units

Language Course (Choose 1)

82-101 Elementary French I 12
82-121 Elementary German I 12
82-161 Elementary Italian I 12

Diction Course (Choose 1)

An introductory course in the applicable language is a corequisite for each of these courses.

57-221 Italian Diction 3
57-222 French Diction 3
57-223 German Diction 3

Literature and Repertoire Course (Choose 1)

An introductory course in the applicable language is a prerequisite for each of these courses.

57-431 Italian Literature and Repertoire 3
57-432 French Literature and Repertoire 3
57-435 German Literature and Repertoire 3

Minimum Units Required for Music Performance/Music (Composition) Minor: 24-42

Faculty

DOUGLAS AHLSTEDT, Associate Professor of Voice M.M., Eastman School of Music; Carnegie Mellon, 1998.

CHRISTOPHER ALLEN, Artist Lecturer in Percussion BM, Curtis Institute of Music; Carnegie Mellon, 2009.

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.

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 Oboe; Carnegie Mellon, 1994.

NEAL BERNTSEN, Artist Lecturer in Trumpet M.M., Northwestern University; Carnegie Mellon, 2003.

RAY BLACKWELL, Vocal Coach and Staff Accompanist M.M., SUNY Binghamton; Carnegie Mellon, 2003.

JEREMY BRANSON, Artist Lecturer in Percussion; Carnegie Mellon, 2009.

WILLIAM CABALLERO, Artist Lecturer in Horn B.M., New England Conservatory; Carnegie Mellon, 2007.

JUDITH CAGLEY, Artist Lecturer in Solfege M.S.Ed., Duquesne University; Carnegie Mellon, 2006.

CHRISTOPHER CAPIZZI, Artist Lecturer in Jazz Piano M.A.M., Carnegie Mellon University; Carnegie Mellon, 2004.

ANDRES CARDENES, Dorothy Richard Starling and Alexander Speyer, Jr. University Professor of Violin; Carnegie Mellon, 1989.

L. MARK CARVER, Associate Teaching Professor in Coaching and Accompanying M.M., Carnegie Mellon University; Carnegie Mellon, 1995.

- REBECCA CHERIAN, Artist Lecturer in TromboneCarnegie Mellon, 1993.
- DENIS COLWELL, Associate Professor and Conductor of the Wind EnsembleCarnegie Mellon, 1980.
- RICHARD COWAN, Assistant Professor of VoiceCarnegie Mellon, 2008.
- 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 Dance M.S., University of Pittsburgh; Carnegie Mellon, 2007.
- ERIC DEFADE, Artist Lecturer in Jazz SaxophoneCarnegie Mellon, 2002.
- MARK DOMENCIC, Artist Lecturer in Music Theory M.M., Carnegie Mellon University; Carnegie Mellon, 2007.
- THOMAS DOUGLAS, Associate Teaching Professor of Voice and Director of Jazz Vocal Ensemble M.M., Duquesne University; Carnegie Mellon, 1991.
- PAUL EVANS, Artist Lecturer in Percussion MM, Temple University; Carnegie Mellon, 1995.
- ROBERT FALLON, Assistant Professor of Musicology Ph.D., University of California, Berkeley; Carnegie Mellon, 2009.
- JAMES FERLA, Artist Lecturer in Guitar M.F.A., Carnegie Mellon University; Carnegie Mellon, 1977.
- CYRUS FOROUGH, Professor of ViolinCarnegie Mellon, 2001.
- NANCY GALBRAITH, Professor of Composition M.M., West Virginia University; Carnegie Mellon, 1984.
- PAUL GERLACH, Artist Lecturer in Music Education M.F.A., Carnegie Mellon University; Carnegie Mellon, 1982.
- MARYBETH GLASGOW SCHOTTING, Artist Lecturer in Violin M.M., Yale University; Carnegie Mellon, 1998.
- NANCY GOERES, Artist Lecturer in Bassoon B.M., Boston University; Carnegie Mellon, 1988.
- ENRIQUE GRAF, Artist Lecturer in PianoCarnegie Mellon, 1996.
- ROSEANNA IRWIN, Associate Teaching Professor of Coaching and Accompanying M.M., Duquesne University; Carnegie Mellon, 1990.
- PAUL JOHNSTON, Artist Lecturer in MusicCarnegie Mellon, 2005.
- ANNABELLE JOSEPH, Professor of Music D.A., Carnegie Mellon University; Carnegie Mellon, 1986.
- KENNETH KEELING, Professor Emeritus of Music D.M.A., Catholic University of America; Carnegie Mellon, 1996.
- CRAIG KNOX, Artist Lecturer in TubaCarnegie Mellon, 2005.
- PETER KOPE, Assistant Teaching Professor of DanceCarnegie Mellon, 2007.
- 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.
- ROBERT LAUVER, Artist Lecturer in Horn.
- BETSY LAWRENCE, Artist Lecturer in Jazz Voice M.M., Manhattan School of Music; Carnegie Mellon, 1996.
- GREGORY LEHANE, Professor of Drama and Music M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991.
- HANNA WU LI, Professor of Piano and Piano Pedagogy M.M., Northwestern University; Carnegie Mellon, 1969.
- JAMES MCINTOSH, Artist Lecture in BagpipesCarnegie Mellon, 1985.
- ANTHONY LORING MCKAY, Professor of Drama B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985.
- LUZ 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.
- STEPHEN NEELY, Artist Lecturer in Eurhythmics M.M., Carnegie Mellon University; Carnegie Mellon, 1998.
- 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.
- PHILIP PANDOLFI, Artist Lecturer in BassoonCarnegie Mellon, 1995.
- 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.
- KAREN ROETHLISBERGER VERM, Chamber Music Coordinator and Staff Accompanist M.M., Cincinnati Conservatory; Carnegie Mellon, 2004.
- MICHAEL RUSINEK, Artist Lecturer in ClarinetCarnegie Mellon, 1998.
- SERGEY SCHEPKIN, Associate Professor of Piano D.M.A., New England Conservatory; Carnegie Mellon, 2003.
- 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.
- TERRY STEELE, Artist Lecturer in SaxophoneCarnegie Mellon, 2008.
- LEWIS STROUSE, Associate Teaching Professor in Music Education D.A., Ball State University; Carnegie Mellon, 1992.
- PETER SULLIVAN, Artist Lecturer in TromboneCarnegie Mellon, 2000.
- 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.
- STEPHEN TOTTER, Artist Lecturer in Voice M.F.A., Carnegie Mellon University; Carnegie Mellon, 1994.
- JEFFREY TURNER, Artist Lecturer in Double Bass M.M., Carnegie Mellon University; Carnegie Mellon, 1989.
- 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.
- LAURA KNOOP VERY, Assistant Professor of Voice M.M., Yale University; Carnegie Mellon, 2008.
- 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 ViolinCarnegie Mellon, 2009.
- CLARA ZAHLER, Associate Teaching Professor of Music Education MAT, Connecticut College; Carnegie Mellon, 2007.
- NOEL ZAHLER, Head and Professor of Music D.M.A., Columbia University; Carnegie Mellon, 2007.
- ISAIAS ZELKOWICZ, Artist Lecturer in Viola M.M., The Juilliard School; Carnegie Mellon, 1981.
- RONALD ZOLLMAN, Associate Professor and Director of Orchestral Studies High Diploma in Orchestral Conducting, Royal Brussels Conservatory; Carnegie Mellon, 2009.

H. John Heinz III College

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 the H. John Heinz III College? Students entering the 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.

The 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 and management. The degree programs offered at the 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/experimental 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 Science in Information Security Policy and Management
- Doctor of Philosophy in Public Policy and Management

Distinctive features of the Heinz College include the quality of its research and teaching, and the attention it gives to the needs of its students. The Heinz College 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.

The 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 the Heinz College different?

Diversity

The Heinz College student body is nationally 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

The 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 the 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 Arts Management and Technology. Heinz College students can work on projects initiated in these centers or as research assistants for center faculty.

Options for Carnegie Mellon Undergraduates

The 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

The Heinz College's Accelerated Masters Program 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 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/academics/default.html>

The Minor in Health Care Policy and Management

Sponsored by:

H. John Heinz III College
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
Brenda Peyser, 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 33 units

Students are required to take the following courses.

79-330	Medicine and Society	9
90-735	Health Economics	12
90-836	Health Systems	6
90-861	Health Policy	6

Elective Courses 27 units

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
90-853	Healthcare Information Systems	12
90-863	Health Policy II	6

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
85-241	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.

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.

The Heinz College 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

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. Following is information on many full-time Carnegie Mellon faculty members who teach and do research at the Heinz College. For a more complete, current list, visit www.heinz.cmu.edu/researchers/faculty/.

For further information about the Heinz College, contact:

Director of Admissions
 H. John Heinz III College
 Carnegie Mellon University
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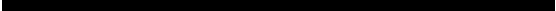
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The College of Humanities and Social Sciences



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The College of Humanities and Social Sciences

John P. Lehoczy, Dean
 Kristina Straub, Associate Dean for Academic Affairs
 Joseph E. Devine, Associate Dean for Undergraduate Studies
 Gloria P. Hill, Assistant Dean and Director, H&SS Academic Advisory Center

www.hss.cmu.edu

The College of Humanities and Social Sciences (H&SS) 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 a college-wide interdepartmental program in Information Systems. The college accounts for approximately one-fifth of the university's undergraduate population; 80% of the college's students are undergraduates. The college is staffed by 203 full-time faculty, and approximately 30 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 H&SS 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, has 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 general emphases on analytical sophistication and application, 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, H&SS 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

H&SS offers a large number and wide range of innovative, rigorous majors and a comparable number of minors. In addition, H&SS students may also apply for admission to one of a number of accelerated masters programs that result in both a bachelor's and master's degree, usually after one additional year.

H&SS Majors

Department	Name of Major (Degree Options)
Economics	Economics (B.A./B.S.)
Economics*	Economics and Mathematical Sciences (B.S.)
English	English (B.A.)
English	Creative Writing (B.A.)
English	Professional Writing (B.A.)
English	Technical Writing and Communication (B.S.)
History	Global Studies (B.A.)
History	History (B.A.)
Interdepartmental	Economics and Statistics (B.S.)
Interdepartmental	Environmental Policy (additional major only)
Interdepartmental	Ethics, History, and Public Policy (B.A./B.S.)
Interdepartmental	European Studies (B.A.)
Interdepartmental	Information Systems (B.S.) (by admission)
Interdepartmental	Linguistics (B.A.)
Interdepartmental	Student Defined (B.A./B.S.)
Modern Languages	Chinese Studies (B.A.)
Modern Languages	French and Francophone Studies (B.A.)
Modern Languages	German Studies (B.A.)
Modern Languages	Hispanic Studies (B.A.)
Modern Languages	Japanese Studies (B.A.)
Modern Languages	Russian Studies (B.A.)
Philosophy	Logic and Computation (B.S.)
Philosophy	Philosophy (B.A.)
Psychology	Cognitive Science (B.S.)
Psychology	Psychology (B.A./B.S.)
Psychology**	Psychology and Biological Sciences (B.S.)
Social and Decision Sciences	Decision Science (B.S.)
Social and Decision Sciences	International Relations and Politics (B.S.)
Social and Decision Sciences	Policy and Management (B.S.)
Statistics	Statistics (B.S.)

Notes:

* with the Department of Mathematical Sciences

** with the Department of Biological Sciences

Additional Majors

H&SS students may pursue additional majors and/or minors in the college, and in some cases in other Carnegie Mellon colleges. An additional major refers to the completion of the requirements for a major program in addition to those required for the primary major. In most cases, requirements for an additional major are the same as those for a primary major.

Most H&SS majors are also available as additional majors; one (Environmental Policy) is available *only* as an additional major. Students from outside H&SS are also eligible to attain an additional major in H&SS programs that offer an additional major option. In such cases, non-H&SS students would be required to complete only those courses in the H&SS general education (GenEd) program that are prerequisites to courses required for the H&SS major they are pursuing. A number of additional majors and minors elsewhere in the university are also available to H&SS students.

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.

In H&SS, there are two types of minors: departmental minors, which are housed in an H&SS academic department; and interdepartmental minors, which are sponsored by more than one department and administered through the faculty advisor's academic department. H&SS minors are available to students from all colleges in the university.

Department	Name of Minor
Economics	Economics
English	English
History	History
Interdepartmental	African and African American Studies
Interdepartmental	Environmental Studies
Interdepartmental	Film and Media Studies
Interdepartmental	Gender Studies
Interdepartmental	Global Systems and Management
Interdepartmental	Health Care Policy and Management
Interdepartmental	Innovation, Entrepreneurship, and Economic Development
Interdepartmental	Linguistics
Interdepartmental	Religious Studies
Interdepartmental	Science, Technology and Society
Interdepartmental	Sociology
Interdepartmental	Student-Defined
Modern Languages	Chinese Studies
Modern Languages	French and Francophone Studies
Modern Languages	German Studies
Modern Languages	Hispanic Studies
Modern Languages	Japanese Studies
Modern Languages	Russian Studies
Philosophy	Ethics
Philosophy	Logic and Computation
Philosophy	Philosophy
Psychology	Psychology
Social and Decision Studies	Decision Science
Social and Decision Sciences	Innovation, Entrepreneurship, and Economic Development
Social and Decision Studies	Policy and Management
Statistics	Statistics

Bachelor of Arts & Bachelor of Science

H&SS majors lead in some cases only to a Bachelor of Arts (B.A.) degree, in other cases only to a Bachelor of Science (B.S.) degree, and in some cases to a choice between a B.A. or a B.S. degree. B.A. degree programs usually require less course work in technical and/or quantitative disciplines, and more depth and breadth in various humanities and (in some cases) arts disciplines. In contrast, B.S. degrees are offered in areas requiring more technical, quantitative or scientific competencies.

H&SS General Education Program

Carnegie Mellon's educational legacy emphasizes the connection between theoretical knowledge and praxis. The university's interdisciplinary approach to education embraces the practical application and analysis of knowledge in institutional, social, and historical contexts. Carnegie Mellon graduates are excellent practitioners in their chosen fields. The H&SS general education program (hereafter referred to as the "GenEd program") supports that expertise and ensures that students gain the well-informed perspectives and methodologies necessary to grow and change with their professions, to interact wisely with the natural environment, and to be responsible and informed citizens in an increasingly technological world and complex global culture.

Broad Aims

The GenEd program provides the integrative component to a Carnegie Mellon H&SS education and extends through the entire undergraduate experience. It sets crucial cornerstones and draws important connections among different facets of students' education. Its distinctive emphases and directions foster intellectual curiosity and encourage students to gain wide, historically informed appreciation of the arts, humanities and sciences; broad understanding of mathematics and experimental methods; critical openness to ethical reflection and social responsibility; and an acute global and environmental awareness.

The GenEd program differs sharply from more traditional liberal arts or general education programs in its emphasis on integration, and not simply breadth. Its courses give students essential knowledge in academic disciplines, while encouraging them to connect fields and to think comparatively about the methods and materials constituting a field of knowledge. The integrative feature of the program goes beyond the purely academic and disciplinary: it asks students to reflect on their role as citizens in a world that demands informed perspectives on social and international issues, diverse cultures, the natural environment, uses of technology, the allocation of human and material resources, and many other challenges in our future.

Categories

To transcend narrow disciplinary confines, the GenEd program focuses on five broad intellectual activities that are exercised in almost all disciplines: communicating, reflecting, modeling, deciding and creating. To indicate their primary or perhaps most striking applications, the activities are supplemented by indications of general subject areas. These form the bases for GenEd curriculum categories, in which suitable courses are organized from all parts of the university.

There are five categories:

1. communicating: language and interpretations
2. reflecting: societies and cultures
3. modeling: mathematics and experiments
4. deciding: social sciences and values
5. creating: designs and productions

The schematic framework highlights central features of an ideal learning environment and the university's core intellectual mission, which is seen as part of a broader human and social enterprise. These features have been identified because they are pervasive and by no means limited to the indicated areas; for example, communicating is crucial across all fields and reflecting is not restricted to thinking about societies and cultures. Students learn to communicate, reflect, model, decide, and create as crucial components of a holistic, integrated educational experience. Later, as students gain expertise in their chosen major, they find that they can exercise these integrative skills both within their primary field as well as with others outside of their primary field.

The GenEd program includes a rich variety of courses. Some courses encourage students to explore a subject in a basic way, providing them with the key building blocks of knowledge in the particular subject. Others are designed to ask students explicitly to reflect on

knowledge, to look at the building blocks from different disciplinary, social, or global perspectives in order to gain a deeper understanding of the arts, humanities, and sciences.

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.

Required		Units
76-101	Interpretation and Argument (Topics vary by section; for current topics, see the HSS GenEd website: http://www.hss.cmu.edu/gened/).	9
xx-xxx	One additional "communicating" course; for approved "communicating" courses, see http://www.hss.cmu.edu/gened/ .	

Note: Non-native English speakers may be placed into 76-100, Reading and Writing for an Academic Context, instead of 76-101 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. For updated lists of other communicating courses, go to the H&SS general education website (www.hss.cmu.edu/gened/).

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.

Required		Units
79-104	Global Histories	9
xx-xxx	One additional "reflecting" course; for approved "reflecting" courses, see http://www.hss.cmu.edu/gened/ .	

For more details about 79-104, and other course listings for this category, visit the H&SS general education website at www.hss.cmu.edu/gened/.

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.

- mathematics (complete a minimum of 9 units)
- natural science (complete a minimum of 9 units)
- one other modeling course (complete a minimum of 9 units)

For updated course offerings, visit the H&SS general education website at www.hss.cmu.edu/gened/.

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
36-201	Statistical Reasoning and Practice	9
xx-xxx	One additional "deciding" course; for approved "deciding" courses, see http://www.hss.cmu.edu/gened/ .	

For updated course offerings, visit the H&SS general education website at www.hss.cmu.edu/gened/.

5. Creating: Designs and Productions (18 units)

In the arts, the humanities, the sciences, and in engineering, it is essential to produce artifacts: ex., 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.

For updated course offerings, visit the H&SS general education website at www.hss.cmu.edu/gened/.

6. TWO Additional GenEd courses (18 units)

These courses can be complete from any GenEd category.

7. University Requirement (UR) (3 units)

This course is a 3-unit mini-course, pass/no credit, completed in the 1st semester.

99-101 /102	Computing @ Carnegie Mellon	Units 3
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8. Freshman Seminar Requirement (FSR) (9 units)

This requirement ensures that all first-year students in H&SS have a small-group course experience in their first year. These seminars consist of substantive academic content drawn from faculty expertise, and also provide a supportive environment for the enhancement of academic skills. For current seminar topics and course descriptions, visit the H&SS general education website at www.hss.cmu.edu/gened/. NOTE: The freshman seminar will not simultaneously fulfill any other requirement (e.g., general education, major or minor requirement).

College Services and Programs

The educational programs in H&SS are complemented by a number of services, special programs, centers, and computing facilities.

H&SS Academic Advisory Center

Gloria P. Hill, Assistant Dean and Director Office: Baker Hall A57
www.hss.cmu.edu/departments/deans_office/aac/hssadvising.html

The H&SS Academic Advisory Center (AAC) is primarily responsible for monitoring the progress of H&SS students prior to entering a major program. As the home base for H&SS students, the AAC provides information, advice, and counsel about scheduling, the college's general education program requirements, and the various majors and minors available. Just as important, advisors also support students' efforts to make a successful transition to university life and study. The advisors consider this kind of information and advice to be vital for students adapting to a new and demanding environment, working their way through the H&SS GenEd program, and preparing for various academic and professional choices to follow.

The AAC is a walk-in center, although individual appointments can be made. 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 Advisor (IRP): Silvia Borzutzky, sb6n@andrew.cmu.edu, 412-268-3250, Porter Hall 223B Faculty Directory (GS): John Soluri, jsoluri@andrew.cmu.edu, 412-268-7122, Baker Hall 363 <http://www.cmu.edu/ir/> <http://www.cmu.edu/hss/globalstudies>

As "globalization" accelerates across many domains (politics, economics, trade, culture, the environment, health, etc.), interest in international issues and topics grows steadily. In order to better reflect Carnegie Mellon's comparative strengths in a range of relevant areas, *two* H&SS majors have emerged from a common foundation in what had been a single interdisciplinary major in International Relations. One (International Relations and Politics) offers strong conceptual and methodological roots in the social sciences, while the other (Global Studies) is more squarely planted in humanities methodologies and disciplines such as history, anthropology, languages, and cultural studies. Students are thus able to capitalize on the strengths of each major's faculty research and teaching in their respective home departments. Having an academic advisor common to both majors provides a critical linchpin to help students with interests in these fields to see and understand their distinctions. They may then work closely with each program's faculty director for assistance in navigation their way through requirements, vigorously pursuing special opportunities such as a semester in Washington, D.C. or study abroad, and taking part in opportunities for inter-program collaboration.

H&SS Senior Honors Program

Joseph E. Devine, Director; Associate Dean for Undergraduate Studies Office: Baker Hall 154F www.hss.cmu.edu/aac/honors

From its inception in 1982, the H&SS senior honors program has provided outstanding undergraduate students with the opportunity to work individually with faculty members throughout the college. The honors program is a senior-year program. Admission to the Program is based on achievement of a cumulative QPA of at least 3.50 in the major and 3.25 overall, endorsement of a thesis proposal by the faculty member who will serve as thesis advisor, and department head approval. Honors students enroll in an honors thesis course sequence for both semesters of the senior year. Upon successful completion of the honors thesis, a student qualifies for graduation with H&SS College Honors, and will have this designation as well as the thesis title noted on the final transcript.

Students have found the honors program to be a very positive experience in allowing for focused, individualized work on a sustained independent project. In the opportunity it provides to demonstrate one's capacity for independent and original work at this level, the senior honors program comprises an experience that helps significantly in presenting oneself to prospective employers or graduate programs.

Humanities Scholars Program

Timothy Haggerty, Director Office: Baker Hall 154Q <http://www.hss.cmu.edu/hsp/>

The Humanities Scholars Program (HSP) is a rigorous, four-year undergraduate program dedicated to fostering innovative interdisciplinary study and research in the humanities. The program works with the undergraduate admissions office to identify a subset of students admitted to H&SS who have a special interest or affinity in the humanities as they are conceptualized at the university. These students are invited into a program that includes a shared set of courses as well as a residential component.

As practiced within its four departments - English, history, philosophy and modern languages - the humanities at Carnegie Mellon provide broad reflective analysis of humanity and its artifacts. Scholarship may incorporate, as examples, hermeneutic, ethnographic, critical, formal, or quantitative analyses within its arguments. At Carnegie Mellon, research has yielded original themes that have become institutional strengths, including social and global perspectives on culture, science and technology; languages, literature and discourse; the arts in society; cognition and rational decision making; and ethics and public policy.

During the first two years of the program, scholars take a series of four seminars that are designed to introduce them to different fields of the humanities and their disciplinary approaches (representative HSP seminars can be viewed on the program website). The program complements, rather than replaces, a major or minor course of study. In addition, HSP courses help fulfill breadth requirements, including the freshman seminar requirement and selected college general education requirements.

While in the program, scholars also participate in extracurricular events on campus and in the community that include talks by visiting scholars, theater performances, conferences, and exhibits that highlight the importance of humanistic inquiry and its relevance in public discourse.

Students complete their research under the direction of a faculty advisor and meet in a research seminar headed by the director of the program in the spring of their fourth year. This seminar is designed to develop and showcase their abilities in addressing a topic from multiple disciplinary standpoints.

Quantitative Social Science Scholars Program

Russell Golman, Director Office: Porter Hall 223J <http://www.hss.cmu.edu/qsss/>

The Quantitative Social Science Scholars Program (QSSS) offers a unique opportunity 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 exciting new possibilities 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 the use of these techniques. It does so by laying out 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 H&SS but open, in principle, to students majoring in other subjects. 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 H&SS 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 get applied both in frontier 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 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 H&SS
- 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 H&SS 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/hss/sdp>

For H&SS students whose educational goals cannot be as adequately served by the curricula of existing majors, 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's dean's office. This proposal, which is to be built on the college's general education program, 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 majors.

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/aac/scholarships_studyabroad.html

The H&SS 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 H&SS, 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 H&SS, 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 H&SS 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.

H&SS Summer Internship Opportunity Grants

http://www.hss.cmu.edu/departments/deans_office/aac/scholarships_summer.html

H&SS encourages students to pursue interesting 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 H&SS 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 H&SS, 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 available resources open to them through the university Career Center and TartanTrak, in their own particular schools and departments, and through experiences of fellow students who have participated in internships during past summers. Preference is given to students who find positions in government or non-profit agencies.

Washington Semester Program

<http://www.cmu.edu/ir/wash-dc-semester-program.html>

From embassy headquarters to non-governmental organizations, from think tanks to lobby groups and advocacy organizations, and from consulting firms to media outlets, Washington, D.C. is both the capital of the United States and a focal point for many of the world's international and public policy activities. Undergraduates from any course of study who would value first-hand policy experience are invited to apply to Carnegie Mellon University's Washington Semester Program, which is sponsored by the university's International Relations and Politics Program. Through this semester-long program, students live, work, and study in Washington, D.C., coming into direct contact with political, business, and community leaders and learning about the most pressing policy issues of the day. The International Relations and Politics Program sponsors policy events and forums in Washington for CMU students participating in the program to further enrich their Washington experience and to help them better understand how Washington functions as a hub of international and public policy decision making. Carnegie Mellon students accepted to WSP are eligible to apply for a Friedman Fellowship, which helps to defray the costs of a semester in Washington, D.C.

Academic Standards, Regulations and Protocols

Transferring into H&SS

Undergraduate students in other Carnegie Mellon colleges who wish to transfer to H&SS apply through the H&SS Academic Advisory Center, Baker Hall A57. If approved, the transfer is into the college first and, 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 H&SS major requested. For more information, see http://www.hss.cmu.edu/departments/deans_office/aac/advisingforms.html

Academic Actions

In order to maintain good academic standing, H&SS students must attain at least minimum quality point averages for each semester and 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.

When a student fails to meet minimum performance criteria, it normally results in an academic action. Depending on the circumstances, one of three actions is taken: academic probation, suspension, or drop. These academic actions are recommended by the college's departments based on the guidelines below. However, the academic actions are not automatic in all cases. They are based on individual student performances and circumstances and are not determined purely by formula.

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.

Suspension

Academic Suspension is the usual action taken when a student fails to meet the minimum semester and 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 two semesters. At the end of that period, a student may seek readmission. In order to receive approval to return, the student must do the following: formally request this approval in writing, describing in detail the relevant activities pursued during the academic suspension period; 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 and addresses of three individuals with whom he or she has worked or studied, to whom the college will write with a request for a letter of reference on the student's behalf.

Once cleared to return from academic suspension, the student must file an application for return from a leave of absence and obtain all necessary signatures. While on academic suspension, students are considered to be on a leave of absence [albeit mandatory], 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 is not permitted to enroll again as an H&SS student. 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.

H&SS Dean's Honor List

Each semester the college recognizes those students who have attained outstanding semester quality point averages by naming them to the H&SS dean's honor list. To be eligible, students must have no conditional grades (i.e., I [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 QPA from 3.50 through 3.74 are named to the Dean's List, with Honors; if the semester QPA 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 QPA 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, and for H&SS students it usually means registering for more than 50 units in one semester. Eligibility to overload is defined as having a QPA of 3.00 (or higher) in the last completed semester and a current cumulative QPA of at least 3.00. Eligibility does not automatically allow the student to register for an overload. Rather, eligible students must request and receive permission through completion of an overload petition and meeting with the student's primary academic advisor to discuss overloading. If approved, online processing of the unit increase is done through the academic advisor.

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.

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 who could be thus 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, StuCo and all military science courses 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 refers to "student-college" - i.e., courses designed by students, and approved to be offered for academic credit. For more information, see <http://www.cmu.edu/stuco/about.html>.

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). Exception: H&SS freshman seminars may not be repeated. 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.

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 and for which a student earns academic credit.

Policies and practices with respect to internships for credit vary among the college's departments. No department is obligated to provide or offer credit for an internship for its majors.

Each department in the college that allows its majors to earn academic credit for an internship determines if and how an internship may be applied to its curriculum for fulfilling course requirements (i.e., whether as a course that fulfills a major requirement, or as an elective course).

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 (12-20 hours) per week during a semester (200 hours)

An H&SS student may not earn more than 18 units of internship credit during a semester or count more than 27 units of internship credit toward fulfilling graduation requirements.

An internship-for-credit is a graded experience. Each department will determine appropriate criteria for the grade in an internship. Students doing an internship for credit must be registered for the internship during the term (including the summer) when they are doing the work.

Some internship sponsors offer payment to an intern in addition to whatever academic credit the university offers.

The university's liability insurance for students does not cover a student while they are doing an internship.

H&SS Credit Policy for Non-Carnegie Mellon Courses

The following policy governs the practice of H&SS 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 they and the institution offering them are of a level and rigor comparable to Carnegie Mellon University.

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 CMU degree. No courses may be transferred for the following H&SS general education requirements:

- 76-101 , Interpretation and Argument (or 76-100) from H&SS general education category communicating
- 79-104 , Global Histories from H&SS general education category reflecting
- 36-201 , Statistical Reasoning from H&SS general education category deciding
- FSR, freshman seminar
- C@CM, Computing @ Carnegie Mellon

In addition, no more than two courses from another institution may be counted for H&SS general education requirements; no more than one course from another institution may count in any one H&SS 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 PCHE, Washington Semester program, study abroad or exchange programs. Exceptions to these restrictions may be made only by way of written petition to the H&SS College Council (c/o the H&SS 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 or 70%. Only units, and not grades, transfer for courses taken elsewhere, and thus do not affect a student's CMU QPA.

External Transfer Students

For students entering CMU/H&SS as external transfers, the same five-course limit applies after they become CMU degree candidates, and until and unless their transfer credits reach the 180 unit ceiling stipulated by university policy. The university has a residency requirement stating that candidates for a bachelor's degree must complete at least four semesters of full-time study (or 180 units). If a degree has been already obtained at another institution (outside of CMU), courses that were counted toward that degree may not be used again as transfer credit toward a CMU undergraduate degree.

Internal Transfer Students

This policy applies retroactively to students who enter H&SS through internal transfer and counts courses taken elsewhere and approved for transfer credit prior to internal transfer to H&SS.

Students on Academic Suspension

Students on academic suspension from H&SS will be permitted to receive credit for no more than three courses per semester elsewhere, and no more than a total of five courses elsewhere, while on suspension. These limits may be lower if the student has already (prior to suspension) had credits transferred under the quota limits. Approval to take these courses for credit is to be obtained in advance.

H&SS Department Limits

H&SS 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 H&SS 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 H&SS 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 H&SS requires that a student:

1. complete all general education requirements,
2. complete all course requirements in the 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 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

H&SS 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 H&SS senior honors program qualify for graduation with H&SS college honors.

H&SS 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 H&SS 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 Statistics

Faculty Advisor: Oded Meyer 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.

Curriculum

Mathematics Requirements (38 Units)

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-259	Calculus in Three Dimensions	9
	or 21-256 Multivariate Analysis and Approximation (9 units)	
21-241	Matrix Algebra	9

Programming Requirement (9 Units)

15-110	Principles of Computing	10
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Writing Requirement (9 Units)

73-270	Writing for Economists	9
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Disciplinary Core - Economics

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

36-202	Statistical Methods	9
	or 36-309 Experimental Design for Behavioral and Social Sciences (9 units)	
	or 70-208 Regression Analysis (9 units)	
36-225	Introduction to Probability Theory	9
	or 36-217 Probability Theory and Random Processes (9 units)	
	or 21-325 Probability (9 units)	
36-226	Introduction to Probability and Statistics II	9
36-401	Modern Regression	9
36-402	Advanced Data Analysis	9

Advanced Economics Electives (18 Units)

Students must take two 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.

Statistical Electives (18 Units)

Students must take two statistics elective courses which are numbered 36-300 and higher.

Sample Course Schedule for the B.S. in Economics and Statistics

First Year

Fall Term		Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning and Practice	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
		49

Spring Term		Units
15-110	Principles of Computing	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Intermediate Microeconomics	9
79-104	Global Histories	9
		46

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
xx-xxx	Open	9
xx-xxx	Open	9
		46

Spring Term		Units
21-241	Matrix Algebra	9
36-226	Introduction to Probability and Statistics II	9
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
73-270	Writing for Economists	9
xx-xxx	Open	9
		48

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

Spring Term		Units
36-402	Advanced Data Analysis	9
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Fourth Year

Fall Term		Units
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Additional Major in Environmental Policy

Peter Madsen, Faculty Director Office: Hamburg Hall 2108A Email: pm2m@andrew.cmu.edu

The additional major (only) in Environmental Policy 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 (e.g., 21-111/112 or 21-121/256)
 Two courses in statistics (e.g., 36-201 and 36-202 or the equivalent)
 Two courses in biology (e.g., 03-121 and 122, 124, or 130)

or

Two courses in chemistry (e.g., 09-103/104 or 09-105/106)

or

Chemistry 09-103 and 06-100 Introduction to Chemical Engineering

The following course is recommended, although not required: 73-100 Principles of Economics.

Research and Analytical Methods 18-21 units

		Units
79-360	Historical Evidence and Interpretation	12
	or 85-340 Research Methods in Social Psychology (9 units)	
88-251	Empirical Research Methods	9
	or 19-446	

Theory and Context 45 units

Required 45 units

		Units
73-148	Environmental Economics	9
73-358	Economics of the Environment and Natural Resources	9
79-289	Energy, Environment, Globalization in the Americas	9
80-344	Management, Environment, and Ethics	9

Required Electives 912 units

Complete one course in one of the following areas:

Science and Technology		
09-510	Introduction to Green Chemistry	9
12-100	Introduction to Civil and Environmental Engineering *	12
12-351	Environmental Engineering	9
12-651	Air Quality Engineering *	9
19-101	Introduction to Engineering and Public Policy	12
19-448	Science, Technology & Ethics	9
19-650	Climate and Energy: Science, Economics and Public Policy	9
24-424	Energy and the Environment	9
88-391	Technology and Economic Growth	9

* 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	9
76-395	Science Writing	9
76-476	Rhetoric of Science	9
79-289	Energy, Environment, Globalization in the Americas	9
79-372	Perspectives on the Urban Environment	9
79-374	American Environmental History: Critical Issues	9
79-375	China's Environmental Crisis	9
79-377	Food, Culture, and Power: A History of Eating	9
80-244	Environmental Ethics	9

(Additional courses may be approved in consultation with the advisor.)

Social Sciences		
73-148	Environmental Economics	9
88-223	Decision Analysis and Decision Support Systems	9
88-302	Behavioral Decision Making	9
90-765	Cities, Technology and the Environment	6
90-798	Environmental Policy & Planning	12
90-808	Energy Policy	6
90-828	Economics of Global Warming	12
(90-xxx)	Heinz College courses open only to seniors)	

(Additional courses may be approved in consultation with the advisor.)

Evaluation and Design 12 units

19-451	EPP Projects (pre-approved sections)	12
or		
19-452	EPP Projects (pre-approved sections)	12
or		
88-220	Policy Analysis I (pre-approved sections)	9
or		
88-221	Policy Analysis II (pre-approved sections)	9
or		
88-222	Policy Analysis III (pre-approved sections)	12

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)
- Policy History (9 units)
- 79-300 History of Public Policy in the United States 9
- U.S. History (9 units)
- 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)
- 79-207 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 I: Earliest Times Origins of the Slave Trades 9
- 79-227 Introduction to African History II: 18th Century to the end of Apartheid 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
- 80-244 Environmental Ethics 9
- 80-245 Medical Ethics 9
- 80-348 Health Development and Human Rights 9
- 80-447 Global Justice 9

IV. Senior Capstone Project Course 12 units

This course will be co-taught by one member of History and one of Philosophy, and be taken in the fall of the senior year by every student majoring in EHPP. The purpose of the course is to give students a serious opportunity to apply the concepts and knowledge they acquired in the major to single topic, in depth.

IV. 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
- 70-332 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
- 73-354 Law And Economics 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
- 73-371 International Trade and Economic Development 9
- 73-372 International Money and Finance 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 African American History II 9
- 79-267 The Soviet Union in World War II: Military, Political and Social History 9
- 79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations 9
- 79-289 Energy, Environment, Globalization in the Americas (formerly 79-263, From Soil to Oil: Energy and the Environment in the Americas) 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, 1967 to the Present 9
- 79-339 The Politics of American Military Recruitment: Historical Perspectives 9
- 79-333 Biology and Society: Evolution Animal Experimentation and Eugenics 9

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79-334	Law, Ethics, and the Life Sciences	9
79-335	Drug Use and Drug Policy	9
79-338	Education and Social Reform	9
79-342	Introduction to Science and Technology Studies	9
79-368	Poverty, Charity, and Welfare	9
79-371	African American Urban History	9
79-374	American Environmental History: Critical Issues	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
80-242	Conflict and Dispute Resolution	9
80-344	Management, Environment, and Ethics	9
80-341	Computers, Society and Ethics	9
80-344	Management, Environment, and Ethics	9
80-256	Modern Moral Philosophy	9

Social and Decision Sciences

88-104	Decision Processes in American Political Institutions	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
88-358	Policy Making Institutions	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

V. 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, or by petitioning the Director of EHPP to accept equivalent courses as substitutions.

36-202	Statistical Methods <small>(Students may take 36-202 OR 36-208)</small>	9
21-257	Models and Methods for Optimization	9
36-207	Probability and Statistics for Business Applications	9
36-208	Regression Analysis	9
36-303	Sampling, Survey and Society	9
80-305	Rational Choice	9
88-251	Empirical Research Methods	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		Senior Year	
Fall	Spring	Fall	Spring
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective	Elective

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

Beryl Schlossman, Professor of French; European Studies Advisor
Office: Porter Hall 125A Email: bfs@cmu.edu

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 is 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.

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.

Complete one course in a 300-level language course 9 units
82-3xx 300-level language course

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

27 units

2. Core Courses in History

Required Course 9 units
79-207 Development of European Culture 9

Pre-20th Century European History 9 units

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

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.

History
79-208 Europe's Two Revolutions: Dynamics of Change in the 19th Century 9

Modern Languages

French:
82-406 Intensive French Language and Culture: Advanced Level Special Topics 9
82-415 /416 Topics in French and Francophone Studies 9

German:
82-427 Nazi and Resistance Culture 9

Spanish:
82-441 Studies in Peninsular Literature and Culture 9
60-377 Picasso and 20th Century Art 9

English
76-331 Renaissance Literary and Cultural Studies 9

New courses will be added as appropriate.

European Studies (B.A.) Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
300-level Language Course 82-3xx	400-level Language Course 82-4xx	European Studies Elective	European Studies Elective
79-207 Development of European Culture	Pre-20th Century European Course 79-2xx/3xx	European Studies Elective	European Studies Elective
Elective	European History Course 79-3xx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

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@cmu.edu Program Advisor: Stephen Pajewski Office: Porte Hall 222F, sp4g@andrew.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 page 227.

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 H&SS 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 The Nature of Language 9

Fundamental Skills

Take **one** course from **each** 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

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 9
82-280 Learning About Language Learning 9
82-383 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

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Area 2: Discourse, Society and Culture	
76-318 Communicating in the Global Marketplace	9
76-385 Introduction to Discourse Analysis	9
76-386 Language & Culture	9
82-273 Introduction to Japanese 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

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	9
76-378 Literacy: Educational Theory and Community Practice	9
76-451 Topics in Language Study	9
76-476 Rhetoric of Science	9
80-281 Language and Thought	9
80-380 Philosophy of Language	9
82-345 Introduction to Hispanic Literary and Cultural Studies	9
82-373 Structure of the Japanese Language	9
82-378 Japanese Conversation Analysis	9
82-388 Understanding Second Language Fluency	9
82-442 Analysis of Spoken Spanish	9
82-444 The Structure of Spanish	9
82-476 Japanese Discourse Analysis	9
82-480 Social and Cognitive Aspects of Bilingualism	9
82-488 Language Learning in a Study Abroad Context	9
80-382 Linguistics of Germanic Languages	9
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

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.

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 H&SS 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 H&SS 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 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 H&SS general education program.

Proposals and curricula are evaluated for clarity of focus, coherence and depth in related areas, and viability within the content of the College and the 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. All Student-Defined Majors must complete the H&SS general education program.

H&SS Interdepartmental Minors

H&SS interdepartmental minors are programs whose content and components span two or more academic departments in the humanities, behavioral sciences, and social sciences to form coherent patterns of study.

A number of interdepartmental minors are offered by H&SS and are, in general, available to all Carnegie Mellon undergraduate students. As well, there are numerous other minors offered by other colleges in the university that are generally available to H&SS students. The full list of minors available to Carnegie Mellon students is located in the catalog index under Minors.

Completion of the requirements for any of these minors is noted on the final transcript.

To declare an H&SS interdepartmental minor, students should contact the H&SS Academic Advisory Center (AAC) and the faculty advisor for that minor.

To discuss the possibilities of declaring other non-H&SS minors contact the advisor listed for that particular minor.

In general, unless noted, no course taken to fulfill requirements for these interdepartmental minors may apply toward any other program's requirements.

The Minor in African and African American Studies

Edda L. Fields-Black, Faculty Advisor 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 African 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.

Requirements

- The minor is composed of 54 units - two core courses and four elective courses.
- The elective courses must include one project 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

African		
79-226	Introduction to African History I: Earliest Times Origins of the Slave Trades	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	9
African American		
76-232	African American Literature	9
79-241	African American History I	9
79-242	African American History II	9
Caribbean		
79-220	Caribbean: Cultures and Histories	9

Elective Courses

36 units

African		
79-162	Freshman Seminar: "Slavery" and "Freedom" in African History?	9
79-290	States/Stateless Societies and Nationalism in West Africa	6
79-291	Globalization in East African History	6
79-385	The Making of the African Diaspora *	9
79-386	Entrepreneurs in Africa, Past, Present and Future *	9
82-304	The Francophone World **	9
88-370	African Politics	9
African American		
57-480 /79-357	History of Black American Music *	6
76-332	African American Literature	9
76-432	Advanced Seminar in African American Studies: Ralph Ellison *	9
79-243	African American Women's History	9
79-286	Gandhi and King: Nonviolent Leadership in a Globalized World	9
79-304	African Americans in Pittsburgh	6
79-371	African American Urban History	9
Caribbean		
79-295	Race Relations in the Atlantic World	9
79-385	The Making of the African Diaspora *	9
82-304	The Francophone World **	9
82-454	The Hispanic Caribbean: Rhyme, Reason and Song **	9
Latin American		
79-317	Art, Anthropology and Empire	9
82-451	Studies in Latin American Literature and Culture	9

Notes:

* Denotes courses that require a research paper/project and fulfill requirement for project course

** Denotes courses taught in a foreign language

The Minor in Environmental Studies

Faculty Advisor: Peter Madsen Office: Hamburg Hall 2108A

Human activities can have large-scale and long-term consequences for environmental quality. The thoughtful analysis of these consequences is required if we desire a sustainable society. The minor in Environmental Studies is designed to provide students with the interdisciplinary background and skills necessary to understand environmental issues. It emphasizes three general areas: humanities, social sciences, and technology and natural science. The humanities emphasis concerns the ethical, legal, and historical basis of environmental concerns. The social science area concentrates on the economic and political nature of environmental problems. The technology and natural science focus includes the exploration of the biological, chemical, and physical nature of the environment and the role of technology in both problem creation and problem solution.

Curriculum

54-73 units

The minor in Environmental Studies is offered jointly by the Departments of History and Social and Decision Sciences, with participation by selected departments from the Mellon College of Science and the Carnegie Institute of Technology. The minor requires that students take Biology and Chemistry in the Mellon College of Science or approved environmentally-related science courses at the University of Pittsburgh. In addition, minors are required to complete two required core courses, three intermediate (distributional) courses spread across at least two of the areas of emphasis, and one advanced course. The advanced course requirement includes either pre-approved sections of Policy Analysis III or pre-approved sections of the History and Policy Project Course. It is important for students to work closely with the faculty advisor for the minor in order to select the proper mix of courses to fulfill requirements.

194 H&SS Interdepartmental Minors

With the exception of the minor's science prerequisites, courses taken to fulfill requirements in other major or minor programs may not be applied to the Environmental Studies minor requirements (and vice versa). In the case of the minor's Advanced Course requirement, if one of the two advanced courses is being taken to fulfill a requirement for another program, it cannot also be applied to this minor requirement. If it is not possible to take the 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
03-121 Modern Biology	9
09-105 Introduction to Modern Chemistry I (equivalent to at least 18 Carnegie Mellon units) at the University of Pittsburgh (see faculty minor advisor)	10

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
	Units
73-148 Environmental Economics	9
80-244 Environmental Ethics	9

Intermediate (Distributional) Requirements 27 units

Complete three courses in at least two of these areas: Science and Technology, Social Science, and Humanities. Only one of the three courses can be an introductory course (as indicated below by an asterisk).

Science and Technology Area	
12-100 Introduction to Civil and Environmental Engineering *	12
12-651 Air Quality Engineering	9
19-101 Introduction to Engineering and Public Policy *	12
19-448 Science, Technology & Ethics	9
19-650 Climate and Energy: Science, Economics and Public Policy	9
24-424 Energy and the Environment	9
88-391 Technology and Economic Growth	9

Social Sciences Area	
73-358 Economics of the Environment and Natural Resources	9
88-220 Policy Analysis I	9
88-221 Policy Analysis II	9
90-765 Cities, Technology and the Environment	6
90-798 Environmental Policy & Planning	12
90-808 Energy Policy	6
90-828 Economics of Global Warming	12

Humanities Area	
76-319 Environmental Rhetoric	9
76-476 Rhetoric of Science	9
79-289 Energy, Environment, Globalization in the Americas	9
79-372 Perspectives on the Urban Environment	9
79-374 American Environmental History: Critical Issues	9
79-375 China's Environmental Crisis	9
79-377 Food, Culture, and Power: A History of Eating	9
80-244 Environmental Ethics	9

Advanced Course	9 units
88-222 Policy Analysis III (additional courses may be approved in consultation with the advisor.)	12

The Minor in European Studies

Faculty Advisor: Beryl Schlossman Office: Porter Hall 125A Email: bfs@andrew.cmu.edu

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.

European Studies minors must take two prerequisite courses (18 units) in the same 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 54 units of core courses. Students are encouraged to take advantage of the Study Abroad Program.

Students are urged to check with the Minor Advisor in selecting courses for this major.

I. Core Courses in Modern Languages 27 units

Starting at the intermediate level or higher, 3 courses are to be completed in the same language area: French, German, or Spanish.

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 or a combination of 300 and 400 level language courses.

Complete one 300-level language course 9 units
 82-3xx 300-level language course

Core Courses in History 27 units

79-207 Development of European Culture 9

Pre-20th Century European History 9 units

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

Complete one 300-level course in European history.
 79-3xx European History course

The Minor in Film and Media Studies

Faculty Advisor: David Shumway Office to declare the minor: Baker Hall 259

Film and the electronic media have become a crucial part of contemporary culture and society; they constitute an important tool for understanding social arrangements, historical changes, and play an increasingly important role in the development of aesthetic and cultural theory. The H&SS minor in Film and Media Studies takes an interdisciplinary approach to the study of film and other electronic media. Courses provide techniques for analyzing and criticizing film and other media, for assessing their value as historical, anthropological and social scientific data, and for understanding the aesthetic and philosophical premises of various media texts. In addition, students may take courses in the processes of film-making, offered through special arrangement with the Pittsburgh Filmmakers (a non-profit media arts center, operating since 1971, that provides workshops, seminars, screenings, exhibitions, and training programs in the media and photographic arts).

Courses taken to fulfill requirements for other major or minor programs may not be applied to the Film and Media Studies Minor requirements.

Curriculum **54 Units**

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.

Introductory Course **9 Units**

76-239 Introduction to Film Studies (prerequisite for 76-439) 9

Required Intermediate Course **9 Units**

76-339 Advanced Film and Media Studies (May be taken up to three times and counted for additional credit toward Intermediate Courses if topics differ) 9
or 76-361 The Film Festival: Faces of Democracy in Contemporary World Cinema (9 units)

Intermediate Courses **18 Units**

Complete a minimum of 18 units of course work, chosen in any combination from the following three course groups. (All courses are 9 units unless otherwise indicated).

1. Film and the Study of Society
76-238 Media and Film Studies 9
82-296 A Century of Russian Film 9

2. Film and Anthropology
79-303 Pittsburgh and the Transformation of Modern Urban America 6

3. Filmmaking
76-269 Survey of Forms: Screenwriting 9
FM 200 Intermediate Filmmaking (please go to CFA 100 to register for this course)

Other 200 or 300 level courses in English, History, and Modern Languages can be counted in this category when their primary topic is film and media. Please consult the minor faculty advisor.

Advanced Courses **9 Units**

Complete one advanced course which concentrates on film directly or which uses it as a tool of social or cultural analysis.

FM 301 Advanced Filmmaking (please go to CFA 100 to register for this course)
76-439 Advanced Seminar in Film and Media Studies 9
76-438 Advanced Seminar in American Literary and Cultural Studies 9
76-469 Advanced Screenwriting Workshop 9
82-491 Literature, Politics and Film in Russia & East Europe Today Var.

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**

76-241 Introduction to Gender Studies * 9
76-245 Shakespeare: Histories and Tragedies 9
76-329 Global Women's Writing 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**

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 Var.

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, 268-6458.

The Minor in Global Systems and Management

Faculty Advisor: Stephen Pajewski Office: PH 222F

This 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 a global organization that has optimized the geographic locations for completing all its work. Graduates across all disciplines are increasingly likely to find themselves working as part of a global development team on a wide variety of business, consumer, and intellectual products and services. 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 College of Humanities and Social Sciences with participation from the Tepper School of Business. The minor is administered by the

H&SS Information Systems program. The minor requires students to complete one Information Systems course (67-329), two courses in Communications, one or two courses in Humanities, Heritage and Culture and one or two courses in International Management.

Students are encouraged to complete a semester of study abroad. A wide variety of courses completed at appropriate foreign institutions as part of semester abroad can be substituted for any requirement except for 67-329. The GSM advisor should be consulted before embarking on the semester of study abroad to identify an appropriate course or courses at the foreign institution that can be used to provide an appropriate substitute for the minor requirement.

Students may apply just one course taken to fulfill requirements in other major or minor programs toward the GSM minor.

NOTE: The courses listed below appear to be offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for GSM. The GSM advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses. Additionally, 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 College and University. Approval must be obtained prior to begin a customized course of study.

Core Course

67-329 Contemporary Themes in Global Systems 9

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 Cross Cultural Psychology 9

Humanities, Heritage and Culture 9-18 units

Complete courses totaling 9-18 units (generally 2 courses), defined as History Department courses that are 200-level or above covering international/regional studies that are outside of U.S. history; or Modern Languages Department courses that are also 200-level or above, also covering international/regional studies (and not language study).

International Management 9-18 units

Complete courses totaling 9-18 units (generally 1 or 2 courses).
 67-331 Technology Consulting in the Global Community Var.
 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
 88-410 The Global Economy: A User's Guide 9
 88-411 The Rise of the Asian Economies 9
 88-412 Economics of Global Warming 9
 88-415 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

The Minor in Health Care Policy and Management

Sponsored by: H. John Heinz III College College of Humanities and Social Sciences Mellon College of Science

Faculty Advisors: Caroline Acker, College of Humanities and Social Sciences Brenda Peyser, 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 33 units

Students are required to take the following courses.
 79-330 Medicine and Society 9
 90-735 Health Economics 12
 90-836 Health Systems 6
 90-861 Health Policy 6

Elective Courses 27 units

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
 90-853 Healthcare Information Systems 12
 90-863 Health Policy II 6

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
 85-241 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.

The Minor in Innovation, Entrepreneurship, and Economic Development

Serguey Braguinsky, Faculty Director Academic Advisor: Emily Half Baker Hall A60C, 412-268-7082 Email: ehalf@andrew.cmu.edu

The pace of technological change has been steadily increasing over the last 100 to 200 years, if not longer. The ability of nations to grow and prosper economically is dependent on their ability to harness the forces of technological change. Today it is common to speak of the knowledge economy in which the success of firms depends on their ability to manage innovation and technological change. Regions all aspire to be the next Silicon Valley and enact all kinds of policies to lure and support innovative firms. Technological change pervades our lives, entering nearly every decision we make. The goal of the minor in Innovation, Entrepreneurship, and Economic Development (IEE) is to equip students to understand the forces underlying and unleashed by technological change in order to become better decisionmakers, managers, policy analysts, and researchers. IEE is available to undergraduate students in all colleges.

This interdisciplinary and interdepartmental minor, composed of courses offered in various departments and colleges throughout the university, is offered through the International Relations and Politics Program and the Department of Social and Decision Sciences, in the College of Humanities and Social Sciences.

In order to complete the minor, students must take six courses: two core courses, and four electives. At most one of these courses may double-count with another major or minor.

Curriculum 54 units

Core Courses	
70-416	New Venture Creation 9
70-418	Financing Entrepreneurship Ventures 9
73-474	The Economics of Ideas: Growth, Innovation and Intellectual Property 9
79-342	Introduction to Science and Technology Studies 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
88-391	Technology and Economic Growth 9
88-410	The Global Economy: A User's Guide 9
88-411	The Rise of the Asian Economies 9
88-413	Energy and Climate: History, Science, Technology, and Policy in the US 1776-2076 9

Electives

The other four required courses can come from the above list of core courses or the following courses that were developed in whole or in part for the minor:

Elective Courses	
08-463	Service Innovation 6
08-533	Privacy, Policy, Law and Technology 9
15-390	Entrepreneurship for Computer Science 9
19-402	Telecommunications, Technology Policy & Management 12
19-448	Science, Technology & Ethics 9
19-609	Public Policy and Regulation 9
24-484	Decision Tools for Engineering Design and Entrepreneurship 12
60-540	The Artist as Entrepreneur 3
73-148	Environmental Economics 9
73-474	The Economics of Ideas: Growth, Innovation and Intellectual Property 9
79-246	Industrial America 9
79-289	Energy, Environment, Globalization in the Americas 9
79-334	Law, Ethics, and the Life Sciences 9
79-372	Perspectives on the Urban Environment 9
79-386	Entrepreneurs in Africa, Past, Present and Future 9
88-378	International Economics 9
88-412	Economics of Global Warming 9
88-415	Global Competitiveness: Firms Nations, and Technological Change 9
88-419	Negotiation 9
88-423	Institutions, Entrepreneurship, and Innovation 9

Students can also nominate up to two courses outside of the above two lists to qualify toward the six courses required for the minor. These courses must be directly relevant to the minor. A student must submit and have approved a petition for a course outside the above lists to qualify for the minor. NOTE: Some courses have additional prerequisites.

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 CMU.

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 H&SS 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	The Nature of Language	9
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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

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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 Language Study: Historical Linguistics	9
82-273	Introduction to Japanese 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
82-345	Introduction to Hispanic Literary and Cultural Studies	9
82-378	Japanese Conversation Analysis	9
82-476	Japanese Discourse Analysis	9

Linguistic Analysis & Conceptual Foundations		
80-380	Philosophy of Language	9
82-373	Structure of the Japanese Language	9
82-442	Analysis of Spoken Spanish	9
82-444	The Structure of Spanish	9
80-382	Linguistics of Germanic Languages	9
11-721	Grammars and Lexicons	12
11-722	Grammar Formalisms	12

Language Technologies		
11-411	Natural Language Processing	12
11-716	Graduate Seminar on Dialog Processing	6
11-761	Language and Statistics	12
11-762	Language and Statistics II	12
15-492	Special Topic: Speech Processing	12

Notes

Course numbers 82-305, 82-311, 82-312, 82-378, 82-476, 82-477, 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.

The Minor in Religious Studies

Faculty Advisor: David Miller Undergraduate Advisor: Naum Kats
Office: Baker Hall 240

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.

No more than 9 units of courses in the minor can be double-counted to fulfill requirements for any other minor or major.

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
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Distribution Requirements 18 units

Complete two courses that are not from the same disciplinary approaches. Examples are listed below. Please see the faculty advisor for other options. Each of the courses that may be chosen to fulfill this requirement takes a specific disciplinary approach to religion and deals with subject matter which is not specific to one religious tradition.

Anthropological Approaches		
79-310	Religions of China	9

Historical Approaches		
79-307	Religion and Politics in the Middle East	9
79-353	Religious Identities and Religious Conflicts in 19th Century Europe	9
79-354	Religion in American Society	9

Philosophical Approaches		
80-276	Philosophy of Religion	9

Textual Approaches		
76-346	Renaissance Studies	9
: Angels and Diplomats		
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	Flesh and Spirit: Early Modern Europe, 1400-1800	9
79-254	The Jewish American Experience	9
79-349	The Holocaust in Historical Perspective	9
79-350	Early Christianity	9
79-352	Christendom Divided the Protestant and Catholic Reformation 1450-1650	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 and vice versa.

Curriculum 54 units
Core Courses 27 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

76-319	Environmental Rhetoric	9
76-395	Science Writing	9
76-476	Rhetoric of Science	9
51-326	Documenting the Visual	9

Area 2. History, Philosophy and Social Studies of Science and Technology (18 units)

79-333	Biology and Society: Evolution Animal Experimentation and Eugenics	9
79-330	Medicine and Society	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 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.

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
79-289	Energy, Environment, Globalization in the Americas	9
79-331	Body Politics: Women and Health in America	9
79-332	Medical Anthropology	9
79-335	Drug Use and Drug Policy	9
79-383	Epidemic Disease and Public Health	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
85-380	In Search of Mind: The History of Psychology	9
88-343	Economics of Technological Change	9

Faculty Advisor, Roberto Weber Program Advisor, Connie Angermeier 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
85-340	Research Methods in Social Psychology	9
88-251	Empirical Research Methods	9

Elective Courses 36 units

Complete four courses 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
79-305	Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967	9
79-306	Delinquency, Crime and Juvenile Justice, 1967 to the Present	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
79-338	Education and Social Reform	9
79-339	The Politics of American Military Recruitment: Historical Perspectives	9
79-340	Who Shall Play? Gender and Race in American Sport	9
79-343	History of American Urban Life	9
79-368	Poverty, Charity, and Welfare	9
79-377	Food, Culture, and Power: A History of Eating	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

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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
80-300	Minds Machines, and Knowledge	9
80-341	Computers, Society and Ethics	9
88-222	Policy Analysis III	12
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
88-413	Energy and Climate: History, Science, Technology, and Policy in the US 1776-2076	9
88-415	Global Competitiveness: Firms Nations, and Technological Change	9
88-419	Negotiation	9
88-423	Institutions, Entrepreneurship, and Innovation	9

Note: Some courses have additional prerequisites.

Economics Program

Dennis Epple, Head of Economics Carol B. Goldberg, Director of Undergraduate Economics Stephanie A. Vega, Academic Advisor Program Office: Tepper School of Business 139 E-mail: econprog@andrew.cmu.edu

<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 development of market strategies, the promulgation of regulatory structures, and the 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. Six 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.

At Carnegie Mellon University, the Undergraduate Economics Program is supported by both the Tepper School of Business and the College of Humanities and Social Sciences. Economics majors are considered members of both colleges and enjoy their full support and services.

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 will be able to identify, explain, and use economic concepts, theories, models, and data-analytic techniques.
- Students will acquire a deep knowledge of economics, mathematics, statistics, and computing, providing the foundation for success in graduate studies and careers in the public and private sectors.
- Students will 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 will acquire the investigative skills necessary for conducting original economic research and participating effectively in project teams.
- Students will 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. 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.

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).

For students who major in other academic fields, an additional major program and a minor degree program in Economics are available. This information can be found following the discussions about the major curricula.

The Majors

The four 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.

Firstyear students are not expected to know which degree option they wish to pursue. For this reason, the firstyear curricula are identical. As students become involved in their course work, participate in the extra and cocurricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes evident.

The B.A. in Economics Curriculum and the B.S. in Economics Curriculum are designed to provide students with a solid understanding of economic theory and quantitative economic analysis. The introductory core disciplinary sequences in economic theory and quantitative analysis are identical: both rely on the same knowledge base of calculus and statistics. Where these two degree programs differ is in their emphases of study in the advanced levels. The advanced data analysis component of the B.A. in Economics Curriculum pays additional attention to ordinal data and the study of surveys. The flexibility of the Special Electives requirement allows students the opportunity to study political, historical, cultural, and social institutions. In the advanced levels of the economic theory component of the B.S. in Economics Curriculum, the foundations of modern economics are examined, using mathematically sophisticated models. The capstone of the two degree programs 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.

The B.S. in Economics and Mathematical Sciences Curriculum 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 slots in this program; interested students may apply as early as their sophomore year.

The B.S. in Economics and Statistics Curriculum is a collaborative effort between the Department of Statistics and the Undergraduate Economics Program. It provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. The major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economics issues through the analysis, synthesis, and reporting of data using the advanced empirical research methods of statistics and econometrics.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree in economics by completing all of the requirements for the B.S. in Economics. 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.

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 H&SS Honors Program website.

The 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: participation in the Junior Honors Research Seminar in Economics, 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 Colloquia.

Accelerated Master's Degree Programs

Accelerated Master's Degree programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Heinz College offers four professional accelerated masters degree programs: a Master of Science in Arts Administration, Master of Science of Health Care and Policy Management, Master of Information Systems Management, and Master of Science in Public Policy and Management. The Tepper School of Business offers one accelerated professional degree, a Master in Business Administration. For more details, visit the Accelerated Master's Degree Programs site on the Undergraduate Economics Program website.

Degree Requirements and Sample Schedules

In addition to completing a minimum 360 units and fulfilling both the H&SS General Education requirements and all University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economics 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. It is the responsibilities of the students to ensure 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 corequisite requirements.

B.A. in Economics Curriculum

Mathematics Prerequisites (19 units)

Courses	Units
21-120 Differential and Integral Calculus	10
21-256 Multivariate Analysis and Approximation	9

Programming Requirement (10 Units)

15-110 Principles of Computing	10
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Writing Requirement (9 units)

73-270 Writing for Economists	9
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Economic Theory Requirements (27 units)

73-100 Principles of Economics	9
73-150 Intermediate Microeconomics	9
73-200 Intermediate Macroeconomics	9

Economic History Requirement (9 Units)

73-310 Evolution of Economic Ideas and Analysis	9
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Quantitative Analysis Requirements (54 Units)

36-201 Statistical Reasoning and Practice	9
36-202 Statistical Methods	9
36-225 Introduction to Probability Theory	9
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9
36-303 Sampling, Survey and Society	9

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 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.

Course List

Representative List of "Special Elective" Courses	Units
79-246 Industrial America	9
79-300 History of Public Policy in the United States	9
79-335 Drug Use and Drug Policy	9
79-375 China's Environmental Crisis	9
79-386 Entrepreneurs in Africa, Past, Present and Future	9
80-130 Introduction to Ethics	9
80-235 Political Philosophy	9
80-305 Rational Choice	9
80-321 Causation, Law, and Social Policy	9
88-387 Social Norms and Economics	9
88-412 Economics of Global Warming	9

A complete and updated list can be found on the B.A. in Economics website.

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)

	Units
73-497 Senior Project	9
or 73-500 Tepper College Honors Thesis I and	
73-501 Tepper College Honors Thesis II	
or 66-501 H&SS Senior Honors Thesis I (9 units) and	
66-502 H&SS Senior Honors Thesis II (9 units)	

Sample Schedule for B.A. in Economics

First Year

Fall Term	Units
21-120 Differential and Integral Calculus	10
36-201 Statistical Reasoning and Practice	9
99-101 Computing @ Carnegie Mellon	3
73-100 Principles of Economics	9
76-101 Interpretation and Argument	9
xx-xxx Freshman Seminar	9
	<hr/> 49

Spring Term	Units
15-110 Principles of Computing	10
36-202 Statistical Methods	9
21-256 Multivariate Analysis and Approximation	9
73-150 Intermediate Microeconomics	9
79-104 Global Histories	9
	<hr/> 46

Second Year

Fall Term	Units
36-225 Introduction to Probability Theory	9
73-200 Intermediate Macroeconomics	9
xx-xxx "Special Elective"	9
xx-xxx Open	9
xx-xxx Open	9
	<hr/> 45

Spring Term	Units
36-226 Introduction to Probability and Statistics II	9
73-270 Writing for Economists	9
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
	<hr/> 45

Third Year

Fall Term	Units
73-261 Econometrics	9
73-310 Evolution of Economic Ideas and Analysis	9
xx-xxx "Special Electives"	9
xx-xxx Open	9
xx-xxx Open	9
	<hr/> 45

Spring Term	Units
36-303 Sampling, Survey and Society	9
xx-xxx Advanced Economics Elective	9
xx-xxx "Special Elective"	9
xx-xxx Open	9
xx-xxx Open	9
	<hr/> 45

Fourth Year

73-497 Senior Project	9
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9

Spring Term	Units
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9
	<hr/> 45

B.S. in Economics Curriculum

Mathematics Requirements (29 Units)

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-259 Calculus in Three Dimensions	9
or 21-256 Multivariate Analysis and Approximation (9 units)	

Programming Requirement (10 Units)

15-110 Principles of Computing	10
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Quantitative Analysis Requirements (27 Units)

36-225 Introduction to Probability Theory	9
or 36-217 Probability Theory and Random Processes (9 units)	
or 21-325 Probability (9 units)	
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9

Writing Requirement (9 Units)

73-270 Writing for Economists	9
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Economic Theory Requirements (39 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

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 elective 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 and	
73-501 Tepper College Honors Thesis II	
or 66-501 H&SS Senior Honors Thesis I (9 units) and	
66-502 H&SS Senior Honors Thesis II (9 units)	

Sample Course Schedule for the B.S. in Economics

First Year

Fall Term	Units
21-120 Differential and Integral Calculus	10
36-201 Statistical Reasoning and Practice	9
73-100 Principles of Economics	9
76-101 Interpretation and Argument	9
99-101 Computing @ Carnegie Mellon	3
xx-xxx Freshman Seminar	9
	<hr/> 49

Spring Term	Units
15-110 Principles of Computing	10
21-259 Calculus in Three Dimensions	9
36-202 Statistical Methods	9
73-150 Intermediate Microeconomics	9
79-104 Global Histories	9
	<hr/> 46

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
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		46
Spring Term		Units
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
73-270	Writing for Economists	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		48

Third Year

Fall Term		Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		45
Spring Term		Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		45

Fourth Year

Fall Term		Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		45
Spring Term		Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/>
		45

B.S. in Economics and Mathematical Sciences Curriculum

Economic Theory Requirements (39 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

Quantitative Analysis Requirements (36 Units)

36-225	Introduction to Probability Theory	9
	or 36-217 Probability Theory and Random Processes (9 units)	
	or 21-325 Probability (9 units)	
36-226	Introduction to Probability and Statistics II	9
73-261	Econometrics	9
36-401	Modern Regression	9

Mathematical Sciences Requirements (92 Units)

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-228	Discrete Mathematics	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-355	Principles of Real Analysis I	9
21-356	Principles of Real Analysis II	9
21-373	Algebraic Structures	9

Programming Requirement (9 Units)

15-110	Principles of Computing	10
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Writing Requirement (9 Units)

73-270	Writing for Economists	9
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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 pre-requisite. 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
21-357	Sequences and Series of Functions	9
21-365	Projects in Applied Mathematics	9
21-366	Topics in Applied Mathematics	9
21-371	Functions of a Complex Variable	9
21-374	Field Theory	9
21-441	Number Theory	9
21-460	Topology	9
21-484	Graph Theory	9
21-499	Undergraduate Research Topic	9

Note: Only one of the following three courses may count towards the required Mathematical Sciences Depth Electives: 21-365, 21-366, or 21-499.

Sample Course Schedule for the B.S. in Economics and Mathematical Sciences

First Year

Fall Term		Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning and Practice	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
		<hr/>
		49

Spring Term		Units
79-104	Global Histories	9
15-110	Principles of Computing	10
73-150	Intermediate Microeconomics	9
21-259	Calculus in Three Dimensions	9
xx-xxx	Open	9
		46

Second Year

Fall Term		Units
21-127	Concepts of Mathematics	9
73-200	Intermediate Macroeconomics	9
36-225	Introduction to Probability Theory	9
21-259	Calculus in Three Dimensions	9
xx-xxx	Open	9
		46

Spring Term		Units
36-226	Introduction to Probability and Statistics II	9
21-241	Matrix Algebra	9
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
		48

Third Year

Fall Term		Units
21-260	Differential Equations	9
73-261	Econometrics	9
73-270	Writing for Economists	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Mathematics Depth Elective	9
		45

Spring Term		Units
21-355	Principles of Real Analysis I	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Mathematics Depth Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Fourth Year

Fall Term		Units
21-228	Discrete Mathematics	9
21-356	Principles of Real Analysis II	9
36-401	Modern Regression	9
73-497	Senior Project	9
xx-xxx	Open	9
		45

Spring Term		Units
21-373	Algebraic Structures	9
xx-xxx	Mathematics Depth Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

B.S. in Economics and Statistics Curriculum

Mathematics Requirements (38 Units)

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-259	Calculus in Three Dimensions	9
	or 21-256 Multivariate Analysis and Approximation (9 units)	
21-241	Matrix Algebra	9

Programming Requirement (9 Units)

15-110	Principles of Computing	10
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Writing Requirement (9 Units)

73-270	Writing for Economists	9
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Disciplinary Core - Economics

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

36-202	Statistical Methods	9
	or 36-309 Experimental Design for Behavioral and Social Sciences (9 units)	
	or 70-208 Regression Analysis (9 units)	
36-225	Introduction to Probability Theory	9
	or 36-217 Probability Theory and Random Processes (9 units)	
	or 21-325 Probability (9 units)	
36-226	Introduction to Probability and Statistics II	9
36-401	Modern Regression	9
36-402	Advanced Data Analysis	9

Advanced Economics Electives (18 Units)

Students must take two 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 elective courses from other departments/programs.

Statistical Electives (18 Units)

Students must take two statistics elective courses which are numbered 36-300 and higher.

Sample Course Schedule for the B.S. in Economics and Statistics

First Year

Fall Term		Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning and Practice	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
		49

Spring Term		Units
15-110	Principles of Computing	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Intermediate Microeconomics	9
79-104	Global Histories	9
		46

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
xx-xxx	Open	9
xx-xxx	Open	9
		46

Spring Term		Units
21-241	Matrix Algebra	9
36-226	Introduction to Probability and Statistics II	9
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
73-270	Writing for Economists	9
xx-xxx	Open	9
		48

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

Spring Term		Units
36-402	Advanced Data Analysis	9
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Fourth Year

Fall Term		Units
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Spring Term		Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		45

Additional Major in Economics Curriculum

The requirements for the Additional Major in Economics are the same as those for the B.S. in Economics, except that the H&SS general education requirements are waived. In order to avoid double counting issues, students are encouraged to meet with an economics advisor.

Minor in Economics

The requirements for a Minor in Economics consist of mathematics requirements, computing requirements, probability and statistics requirements, and economics courses listed below. In order to avoid double counting issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements (19 Units)

		Units
21-120	Differential and Integral Calculus	10
21-256	Multivariate Analysis and Approximation	9

Computing Requirements (10 Units)

		Units
15-110	Principles of Computing	10

Economic Theory Requirements (27 Units)

73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
73-200	Intermediate Macroeconomics	9

Quantitative Analysis Requirements (27 Units)

		Units
36-225	Introduction to Probability Theory or 21-325 Probability (9 units) or 36-217 Probability Theory and Random Processes (9 units)	9
36-226	Introduction to Probability and Statistics II	9
73-261	Econometrics	9

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.

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. DERDINGER, 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.

GEORGE-LEVI GAYLE, Assistant Professor of Economics and Strategy Ph.D., University of Pittsburgh; Carnegie Mellon, 2003.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy, H. J. Heinz III College Ph.D., Northwestern University; Carnegie Mellon, 1995.

LIMOR GOLAN, Associate Professor of Economics Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002.

MARVIN GOODFRIEND, Professor of Economics; Chairman, The Henry J. Gailliot 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. 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.

ONUR KESTEN, Assistant Professor of Economics Ph.D., University of Rochester; Carnegie Mellon, 2005.

STEVEN KLEPPER, Arthur Arton Hamerschlag 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.

FINN KYDLAND, The Richard P. Simons Distinguished Professorship; University Professor of Economics; Nobel Laureate (2004) Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977.

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.

BENNETT T. 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.

ROBERT A. MILLER, Professor of Economics and Strategy Ph.D., University of Chicago; Carnegie Mellon, 1982.

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. SEPPI, 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 (On leave 2010-2011AY).

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

Department of English Christine Neuwirth, Department Head Kristina Straub, Associate Head Department Office: Baker Hall 259

<http://english.cmu.edu/>

The Department of English at Carnegie Mellon involves students in the important study of reading and writing as they are embedded in historical, cultural, professional, technological, and literary practices. Working with faculty who are themselves writers, scholars, and researchers in these areas, students become effective writers and analysts of various kinds of texts in a range of media. We hold strongly to our traditional interest in print documents but extend the idea of text to include other media such as film, multimedia, and on-line texts. The types of texts that students and faculty work with include academic writing, criticism, fiction and nonfiction, professional and technical writing, argument and public advocacy, poetry, film, and even screenwriting. The English Department faculty have particular strengths in Creative Writing, in Literary and Cultural Studies, and in Rhetoric. Specialists in each area use distinctive methods of studying texts, but all share a deep commitment to working in small and intense workshops and seminars to help students learn to become experts in analyzing existing texts, and in producing original and distinctive work of their own.

The English Department offers a B.A. in English, a B.A. in Creative Writing, a B.A. in Professional Writing, and a B.S. in Technical Writing and Communication. All four majors involve the relationship of texts to contexts, and all four are structured to allow students to balance liberal and professional interests. Students in the English B.A. focus on the production and interpretation of print texts and other media in their social and cultural contexts. Students in the Creative Writing B.A. focus on analyzing and learning to produce poetic and narrative forms. Students in the Professional Writing B.A. focus on analyzing and producing non-fiction for a variety of professional contexts. Students in the Technical Writing B.S. focus on integrating writing with technical expertise in a chosen area of concentration. In addition to the four majors, the department offers a minor in English and strongly encourages non-majors in the campus community to join us in English courses, beginning with offerings at the 200-level.

English faculty and students represent a diverse but close community with a shared interest in understanding how texts are produced and understood. This interest is the foundation for the formal curriculum and also the inspiration for a range of complementary activities, including a reading series of distinguished writers of poetry, fiction, and non-fiction. English majors also have multiple opportunities to gain experience in publishing, editing, and marketing through involvement with *The Oakland Review* and The Carnegie Mellon University Press. Many of our students hold writing and editorial positions on the student newspaper, *The Tartan*, and other campus publications. We also offer a strong internship program that places student writers in media, non-profit, arts, corporate, and technical internships before they graduate. The end of every year culminates in a gala event to celebrate our students and their writing achievements in literary, academic, and professional writing. For this event, known as the Pauline Adamson Awards, we invite a well-known writer to do a public reading and then present and celebrate student writing awards in over a dozen categories, all judged anonymously by writing professionals from outside the university. Nationally prominent speakers who have participated in this event include Michael Cunningham, Jamaica Kincaid, Michael Ondaatje, Tobias Wolfe, Elizabeth Alexander, and Dennis Lehane.

Undergraduate students also have the opportunity to apply to the various Masters level graduate programs sponsored by the department. Students interested in communications careers in both the public and private sectors may receive advanced training in our Masters in Professional Writing (MAPW) program. Students who have interests in visual as well as verbal communication apply to the Masters in Design in Communication Planning and Information Design (jointly administered with the School of Design). Students with academic interests looking toward doctoral work can apply to our Masters programs in Rhetoric and in Literary and Cultural Studies to acquaint themselves with and to prepare for academic careers. The best of our Masters candidates may request consideration for the Department's Ph.D. programs in Rhetoric or in Literary and Cultural Studies and will be, in any case, well prepared for graduate work no matter where they chose to go. Upper level undergraduates interested in graduate level work should contact the English Department directly for further information and for advice on planning their junior and senior years to prepare for graduate study.

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 H&SS 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 pre-requisite.

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 H&SS 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	9

Complete six required courses.

Research Course

76-394 Research in English

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.

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	9
76-331	Renaissance Literary and Cultural Studies	9
76-332	African American Literature	9
76-335	20th Century Literary and Cultural Studies: Postmodern Am/Brit Fiction and Film	9
76-339	Advanced Film and Media Studies	9
76-347	American Literary and Cultural Studies: Contemporary Fiction	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
76-393	Rhetorical Traditions	9
76-492	Rhetoric of Public Policy	9

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	9
76-439	Advanced Seminar in Film and Media Studies	9
76-451	Topics in Language Study	9
76-457	Topics in Language Study: Historical Linguistics	9
76-476	Rhetoric of Science	9
76-482	Comparative Rhetoric	9

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

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 H&SS 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	Junior Year	
Fall	Fall	Spring
76-294 Interpretive Practices	76-26x Survey of Forms	76-3xx 300-level EBA Course*
	76-394 Research in English	76-3xx/4xx Rhetoric Course
	76-3xx/4xx Rhetoric Course	76-2xx/3xx/4xx English Elective
	76-2xx/3xx/4xx English Elective	Elective
	Elective	Elective
	Elective	

Senior Year	
Fall	Spring
76-4xx 400-level Seminar**	76-4xx 400-level Seminar**
76-3xx 300-level EBA Course*	76-3xx/4xx English Elective
76-3xx/4xx English Elective	Elective
Elective	Elective
Elective	Elective

* 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, and other imaginative forms. While studying with faculty members who are practicing poets and fiction 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 other nationally known poets and fiction writers through the department's Visiting Writers series. The CW program, based on a conservatory model, 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 H&SS 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 each 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 H&SS 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 Hilary Masters Award in Personal Essay, 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 H&SS 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)

76-260	Survey of Forms: Fiction *	9
76-261	Survey of Forms: Creative Nonfiction *	9
76-265	Survey of Forms: Poetry *	9
76-269	Survey of Forms: Screenwriting *	9

* 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:

76-362	Reading in Forms: Nonfiction	9
76-363	Reading in Forms: Poetry	9
76-364	Readings in Forms: Fictions	9

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.

76-365	Beginning Poetry Workshop	9
76-460	Beginning Fiction Workshop	9
76-462	Advanced Fiction Workshop	9
76-464	Non-Fiction Workshop: Personal Essay	9
76-465	Advanced Poetry Workshop	9
76-469	Advanced Screenwriting Workshop	9
76-4xx	Elective Workshops (various forms)	

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 with the exception of Introduction to Creative Writing (76-206), which is designed primarily for non-majors. 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 H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

Junior		Senior	
Fall	Spring	Fall	Spring
76-26x Survey of Forms	76-26x Survey of Forms	76-3xx/4xx Creative Writing Workshop	76-3xx/4xx Creative Writing Workshop
76-36x Reading in Forms	76-3xx/4xx Creative Writing Workshop	76-3xx/4xx Creative Writing Workshop	76-3xx/4xx English Elective
76-2xx/3xx/4xx English Elective	76-3xx/4xx English Elective	76-3xx/4xx English Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

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 + 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 specializations 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, and 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 opportunities for students to publish their own written work and 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 Hospital Foundation, and the Pittsburgh Symphony; traditional and new media PR and information design agencies such as Deeplocal, Mind over Media, Marc, and Branding Brands; publications such as Whirl, Pittsburgh Magazine, and the Pittsburgh Post Gazette; TV stations WTAE, KDKA, and WQED; and organizations as diverse as NFL films, The Latin American Literary Review Press, the Lincoln Center Festival, and the New York Islanders. Ideas and guidance for choosing internships, courses, summer employment, and possible career paths are provided

through a 3-unit course, Professional Seminar (76-300), which meets once a week during the fall term and provides majors with the opportunity to meet and network with practicing professionals in a range of communications fields.

Curriculum

In addition to satisfying all of the H&SS degree requirements for B.A. candidates, Professional Writing majors must fulfill 12 requirements in the following areas:

Professional Writing Core (9 courses, 81 units)

Complete nine courses.

Foundations 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
76-390	Style	9
76-373	Topics in Rhetoric: Argument	9

Rhetoric/Language Studies Requirement (1 course, 9 units)

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. 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 Courses	Units	
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 & Culture	9
76-387	Sociolinguistics	9
76-389	Rhetorical Grammar	9
76-419	Communication Revolutions & Technologies	9
76-420	Process of Reading and Writing	9
76-428	Visual/Verbal Communication	9
76-451	Topics in Language Study	9
76-457	Topics in Language Study: Historical Linguistics	9
76-476	Rhetoric of Science	9
76-491	Rhetorical Analysis	9
76-492	Rhetoric of Public Policy	9

Advanced Writing/Rhetoric Courses (4 courses, 36-42 units)

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. 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 PW majors, regardless of their career focus, are encouraged to take 76-391 Document Design and 76-487 Online Information 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	Units	
76-301	Internship	Var.
76-359	Planning and Testing Documents	9
76-360	Literary Journalism Workshop	9
76-372	Introduction to Journalism	9
76-375	Magazine Writing	9
76-389	Rhetorical Grammar	9
76-391	Document Design	12
76-395	Science Writing	9

76-396	Non-Profit Communication: Genres, Methods, and Issues *	9
76-397	Instructional Text Design *	9
76-452	Patterns of English Usage	9
76-464	Non-Fiction Workshop: Personal Essay	9
76-472	Advanced Journalism	9
76-474	Software Documentation	9
76-479	Marketing, Public Relations, and Corporate Communications	9
76-481	Writing for Multimedia	12
76-487	Online Information Design	9
76-491	Rhetorical Analysis	9
76-494	Healthcare Communications	9
39-605	Engineering Design Projects	12

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 76-272 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 be. 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 Online Information 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.)

Junior		Senior	
Fall	Spring	Fall	Spring
76-271 Introduction to Professional and Technical Writing	76-26x Survey of Forms	76-3xx/4xx Rhetoric or Advanced Writing/Rhetoric Course	76-3xx/4xx Advanced Writing/Rhetoric Course
76-390 Style	76-373 Topics in Rhetoric: Argument	76-3xx/4xx Advanced Writing/Rhetoric Course	76-3xx/4xx Advanced Writing/Rhetoric Course
76-2xx/3xx/4xx English Elective	76-3xx/4xx Rhetoric or Advanced Writing/Rhetoric Course	76-3xx/4xx English Elective	76-3xx/4xx English Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

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 subjects. 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 finances to complex data 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 (TC) 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 TC 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 else, they 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 Institute of Technology, the Mellon College of Science, and the 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 develop the broad intellectual background 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 summers. 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 on- and 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 TWC/TC major can be pursued as a primary major within H&SS 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 H&SS 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 H&SS 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 H&SS 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	9

Statistics Prerequisite (1 course, 9 units)

Complete one course

36-201	Statistical Reasoning and Practice	9
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Computer Science Prerequisites (2 courses*, 20 units)

Note: At the time the Undergraduate Catalog went to press, Computer Science was in the process of substantially revising their curriculum and course offerings. The following requirements thus are provisional and subject to revision when new course descriptions become available. All courses listed below are scheduled to be offered in 2010-11. Please consult the Department of English or the Director of Professional & Technical Writing for the most up-to-date information.

Complete two of the following courses:

- 15-101 Exploring Programming with Alice 10
- or 15-102 Exploring Programming with Graphics (10 units)
- 15-110 Principles of Computing * 10

* 15-110 is a prerequisite for 15-121. Students who qualify to enroll in 15-121 on the basis of prior experience or who have taken 15-121 as part of their requirements for another degree can satisfy the CS prerequisites for TWC with 15-121 alone.

Additional Advice on Choosing Computer Science Courses for TWC

15-101, 15-102, and 15-110 are all designed for novices with no prior programming experience and are appropriate for students in both the SMC and TC tracks. 15-121 is most necessary and recommended for students in the TC track with interests in going into technical writing in the software industry.

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 3 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 Online Information Design ** 9
- 76-488 On-Line Information 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
- 76-419 Communication Revolutions & Technologies 9
- 76-474 Software Documentation 9
- 76-481 Writing for Multimedia * 12

or

Additional Options

- 76-301 Internship Var. 9
- 76-318 Communicating in the Global Marketplace 9
- 76-385 Introduction to Discourse Analysis 9
- 76-386 Language & Culture 9
- 76-387 Sociolinguistics 9
- 76-389 Rhetorical Grammar 9
- 76-395 Science Writing 9
- 76-397 Instructional Text Design 9
- 76-419 Communication Revolutions & Technologies 9
- 76-428 Visual/Verbal Communication 9
- 76-476 Rhetoric of Science 9
- 76-492 Rhetoric of Public Policy 9
- 39-605 & 39-606 Engineering Design Projects-Engineering Design Projects 12

Additional courses that fulfill these requirements may be available and will be announced on a semester-by-semester basis.

Technical Communication Electives (3 courses, 27 units)

Complete 3 advisor-approved electives in management, technology, and social issues, chosen from the following options. Additional options may be advertised on a semester-by-semester basis. Note that at least some of these courses may have prerequisites. Please check course listings for details and plan accordingly. Courses in this category may double count for both the TWC/TC degree and a major or minor in another department.

- 05-410 Human-Computer Interaction Methods 12
- 05-413 Human Factors 9
- 05-499 Special Topic's in HCI Var.
- 15-105 Principles of Computation 9
- 15-xxx Computer Science courses beyond the 2 required
- 19-448 Science, Technology & Ethics 9
- 36-309 Experimental Design for Behavioral and Social Sciences 9
- 36-350 Data Mining 9
- 51-261 Communication Design Fundamentals 9
- 51-262 Communication Design Fundamentals 9
- 51-263 Industrial Design Fundamentals 9
- 70-311 Organizational Behavior 9
- 70-332 Business, Society and Ethics 9
- 70-342 Managing Across Cultures 9
- 80-220 Philosophy of Science 9
- 80-221 Philosophy of Social Science 9
- 80-241 Ethical Judgments in Professional Life 9
- 80-242 Conflict and Dispute Resolution 9
- 80-243 Business Ethics 6
- 80-244 Environmental Ethics 9
- 80-291 Issues in Multimedia Authoring 9
- 80-341 Computers, Society and Ethics 9
- 85-211 Cognitive Psychology 9
- 85-213 Human Information Processing and Artificial Intelligence 9
- 85-241 Social Psychology 9
- 85-370 Perception 9
- 85-392 Human Expertise 9
- 85-395 Applications of Cognitive Science 9
- 05-432 Cognitive Modeling and Intelligent Tutoring Systems 9
- 88-223 Decision Analysis and Decision Support Systems 9
- 88-260 Organizations 9
- 88-341 Organizational Communication 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. 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 4 prerequisite courses, which should be completed by the junior year.

Sophomore Year	Junior Year	
	Fall	Spring
76-271 Introduction to Professional and Technical Writing*	76-391 Document Design*	76-3xx/4xx Theory/Specialization Course
76-390 Style	76-26x Survey of Forms	Technical Communication Elective
Elective	Technical Communication Elective	Elective
Elective	Elective	Elective
Elective	Elective	Elective

Senior Year	
Fall	Spring
76-487 Online Information Design*	76-3xx/4xx Theory/Specialization Course
76-488 On-Line Information Design Lab	Technical Communication Elective
76-3xx/4xx Theory/Specialization Course	Elective
Elective	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	Online Information Design **	9
76-488	On-Line Information 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 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)		Units
76-395	Science Writing *	9
76-476	Rhetoric of Science	9
76-494	Healthcare Communications *	9

Additional Options		Units
76-301	Internship	Var.
76-318	Communicating in the Global Marketplace	9
76-359	Planning and Testing Documents	9
76-372	Introduction to Journalism	9
76-385	Introduction to Discourse Analysis	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
76-389	Rhetorical Grammar	9
76-396	Non-Profit Communication: Genres, Methods, and Issues *	9
76-397	Instructional Text Design *	9
76-419	Communication Revolutions & Technologies	9
76-428	Visual/Verbal Communication	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
42-101	Introduction to Biomedical Engineering	12
42-202	Physiology	9
42-444	Medical Devices	9

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 4 prerequisite courses, which should be completed no later than the end of the junior year.

Sophomore Year	Junior Year	
Spring	Fall	Spring
76-271 Introduction to Professional and Technical Writing*	76-391 Document Design*	76-3xx/4xx Theory/Specialization Course
76-390 Style	76-26x Survey of Forms	Technical Communication Elective
Elective	Technical Communication Elective	Elective
Elective	Elective	Elective
Elective	Elective	Elective

Senior Year	
Fall	Spring
76-487 Online Information Design*	76-3xx/4xx Theory/Specialization Course
76-488 On-Line Information Design Lab	Technical Communication Elective
76-3xx/4xx Theory/Specialization Course	Elective
Elective	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.

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 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/SMC 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 for 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 except Introduction to Creative Writing (76-206), which is designed primarily for non-majors.

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
76-36x	/46x 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 except Introduction to Creative Writing (76-206), which is designed primarily for non-majors.

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	9
	or 76-271 Introduction to Professional and Technical Writing (9 units)	
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 Introduction to Journalism, 76-375 Magazine Writing, 76-389 Rhetorical Grammar, 76-390 Style, 76-391 Document Design, 76-395 Science Writing, 76-396 Non-Profit Communication: Genres, Methods, and Issues 76-472 Advanced Journalism, 76-479 Marketing, Public Relations, and Corporate Communications, 76-481 Writing for Multimedia, 76-487 Online Information 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 except Introduction to Creative Writing (76-206), which is designed primarily for non-majors.

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
76-3xx	/76-4xx Two 300- or 400-level courses chosen from the Writing Course Options listed below *	18
76-3xx	/4xx One Rhetoric/Language Studies course	9
76-xxx	One 200-level or above English Elective **	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 Introduction to Journalism, 76-391 Document Design, 76-395 Science Writing, 76-397 Instructional Text Design, 76-419 Communication Revolutions & Technologies 76-474 Software Documentation, 76-479 Marketing, Public Relations, and Corporate Communications, 76-481 Writing for Multimedia, 76-487 Online Information Design, 76-488 On-Line Information 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 Online Information Design.

** The English Elective may be any course offered by the English Department except Introduction to Creative Writing (76-206), which is designed primarily for non-majors.

Senior Honors Thesis

Seniors in all four majors in the English Department who meet the necessary requirements are invited by the College of Humanities and Social Sciences (H&SS) 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 H&SS 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 H&SS to participate. Students then choose a thesis advisor within the Department and propose and get approval from H&SS 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.

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 IJ 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.

JANE BERNSTEIN, Professor of English and Creative Writing M.F.A., Columbia University; Carnegie Mellon, 1991.

CLAUDIA CARLOS, Assistant Professor of English and Rhetoric Ph.D., University of Illinois; Carnegie Mellon, 2005.

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.

DAVID DEMAREST, Professor Emeritus of English.

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.

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 of the Humanities, Rhetoric and Linguistics Ph.D., University of Texas; Carnegie Mellon, 1990.

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.

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, 1997.

RICHARD PURCELL, Assistant Professor of English and Literary and Cultural Studies Ph.D., University of Pittsburgh; Carnegie Mellon, 2008.

ANDREEA RITIVOI, Associate Professor of English and Rhetoric Ph.D., University of Minnesota; Carnegie Mellon, 2001.

KAREN SCHNAKENBERG, Teaching Professor of Rhetoric and Professional Writing; Director of Masters in Professional Writing Program 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 WARREN, Assistant Professor of English and Literary and Cultural Studies Ph.D., University of Oxford; Carnegie Mellon, 2010.

DANIELLE WETZEL, Assistant 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.

JAMES WYNN, Assistant Professor of English and Rhetoric Ph.D., University of Maryland; Carnegie Mellon, 2006.

RICHARD YOUNG, Professor Emeritus of English.

Department of History

Joe W. Trotter, Department Head
Department Office: Baker Hall 240

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 H&SS minors in such fields as African and African-American Studies; Gender Studies; Film and Media Studies; Religious Studies; Environmental Studies; Policy and Management; 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; please 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 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)

79-104 Global Histories 9

II. Required Survey Courses (27 units)

Choose one 9-unit course from each category below.

Category 1: United States (9 units)

79-240 The Development of American Culture 9

Category 2: Regional (9 units) (Europe, East Asia, South Asia, Africa, Latin America, Caribbean, Middle East)

(Choose one)

79-202	Flesh and Spirit: Early Modern Europe, 1400-1800	9
79-205	20th Century Europe	9
79-207	Development of European Culture	9
79-208	Europe's Two Revolutions: Dynamics of Change in the 19th Century	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
79-226	Introduction to African History I: Earliest Times Origins of the Slave Trades	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	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

Category 3: Non-U.S./National (9 units) (Russia/USSR, Spain, Germany, France, China, etc)

(Choose one)

79-255	Irish History	9
79-256	20th Century Germany	9
79-257	Germany and the Second World War	9
79-258	French History: From the Revolution to De Gaulle	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, 1978-2008	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

III. Required Introductory Research Course (12 units)

79-360	Historical Evidence and Interpretation	12
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IV. Distribution Requirements (36 units)

(complete 4 courses)

In addition to the above requirements, the B.A. in History requires that students take at least two additional 9-unit courses numbered 79-202 to 79-354 and at least two 9-unit courses numbered 79-361 to 79-399 (courses with a research component). At least two of the four distribution courses must be substantially devoted to periods before 1900, not including required courses or courses used to satisfy other requirements for the B.A. in History; in other words, no double counting is permitted.

Courses on eras before 1900 (two courses are required, for a total of 18 units)

79-202	Flesh and Spirit: Early Modern Europe, 1400-1800	9
79-212	China and Its Neighbors: Minorities, Conquerors and Tribute Bearers	9
79-220	Caribbean: Cultures and Histories	9
79-222	Between Revolutions: The Development of Modern Latin America	9
79-224	Mayan America	9
79-226	Introduction to African History I: Earliest Times Origins of the Slave Trades	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	9
79-229	Origins of the Arab-Israeli Conflict, 1880-1948	9
79-241	African American History I	9
79-243	African American Women's History	9
79-244	Women in American History	9
79-246	Industrial America	9
79-247	The Civil War Era, 1848-1877	9
79-255	Irish History	9
79-258	French History: From the Revolution to De Gaulle	9
79-261	Chinese Culture and Society	9
79-265	Russian History: From the First to the Last Tsar	9
79-281	Introduction to Religion	9
79-288	Bananas, Baseball, and Borders: A History of Latin America - US Relations	9

79-292	China Inside Out: Going Global, 19th and 21st Centuries	9
79-293	Inward Odyssey	9
79-305	Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967	9
79-308	18th Century China Through Literature	9
79-310	Religions of China	9
79-319	Protest and Dissent in American History	9
79-322	Family and Gender in Russian History	9
79-323	Family Gender and Sexuality in European History, 500-1800	9
79-327	History of the American Working Class	9
79-329	History of Feminist Theory	9
79-330	Medicine and Society	9
79-335	Drug Use and Drug Policy	9
79-343	History of American Urban Life	9
79-347	Cross-breeds: Racial Mixing in American History and Culture	9
79-350	Early Christianity	9
79-352	Christendom Divided the Protestant and Catholic Reformation 1450-1650	9
79-353	Religious Identities and Religious Conflicts in 19th Century Europe	9
79-354	Religion in American Society	9
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
79-372	Perspectives on the Urban Environment	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

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
79-363	The Rise of Modern Golf, 1860 to the Present	9
79-368	Poverty, Charity, and Welfare	9
79-371	African American Urban History	9
79-372	Perspectives on the Urban Environment	9
79-374	American Environmental History: Critical Issues	9
79-375	China's Environmental Crisis	9
79-376	Nationalism and Ethnicity	9
79-377	Food, Culture, and Power: A History of Eating	9
79-379	Extreme Ethnography	9
79-382	History of Biomedical Research	9
79-383	Epidemic Disease and Public Health	9
79-385	The Making of the African Diaspora	9
79-386	Entrepreneurs in Africa, Past, Present and Future	9
79-389	Stalin and Stalinism	9
79-390	Nazi Germany	9
79-391	Comparative Postwar Societies	9
79-392	History of Modern Warfare	9
79-395	The Arts in Pittsburgh	9
79-396	Music and Society in 19th and 20th Century Europe and the U.S.	9
79-398	Documenting the 1967 Arab-Israeli War	9
79-399	US-Arab Encounters	9

V. Senior Capstone Research Seminar (12 units)

79420 Advanced Studies in History

B.A. in History - Sample Curriculum

Pre-requisite: 79-104 Global Histories

Junior		Senior	
Fall	Spring	Fall	Spring
79-240 The Development of American Culture	Regional Survey	Non-U.S. Survey	Distribution Requirement (Pre-1900)
79-360 Historical Evidence and Interpretation	Distribution Requirement (Research)	79-420 Advanced Studies in History	Distribution Requirement (Research)
Elective	Distribution Requirement (pre-1900)	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

The table above represents a two-year (junior-senior) plan for completing all requirements for the B.A. in History. The purpose of this table is merely to show that the B.A. in History can be completed in as few as two years; not that it must be. Students may declare the B.A. in History and begin course requirements as early as the start of the sophomore year and in some instances in the first year. Students should consult the department's academic advisor, Dr. Naum Kats, for both short- and long-term course planning.

Additional Major

The B.A. in History may be scheduled as an additional major in consultation with the departments concerned. Details for declaring a general minor in the Department of History may be found below.

The B.A. in Global Studies

John Soluri, Faculty Director; jsoluri@andrew.cmu.edu, Baker Hall 363, 412-268-7122 Emily Half, Academic Advisor; ehalf@andrew.cmu.edu, Baker Hall A60C, 412-268-7082 <http://www.cmu.edu/hss/globalstudies>

The B.A. in Global Studies is an interdepartmental major designed for students interested in humanistic approaches to understanding past and present processes of globalization. Participating faculty in the departments of History, Modern Languages, English, and Philosophy conduct research in Africa, China, Europe, Japan, Latin America, the Pacific, and South Asia. The 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. In other words, 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 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 93 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)

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 topics underpinning the B.A. in Global Studies, students select 18 units (typically two classes) from the following core courses:

79-276	Theory and Practice in the Anthropology of Globalization	9
79-278	Rights to Representation: Indigenous People and their Media	9
79-280	Experiencing Globalization	9
79-289	Energy, Environment, Globalization in the Americas	9
79-313	Objects of Value	9
79-317	Art, Anthropology and Empire	9
79-376	Nationalism and Ethnicity	9
79-377	Food, Culture, and Power: A History of Eating	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
76-329	Global Women's Writing	9
76-337	Global Literature	9
79-212	China and Its Neighbors: Minorities, Conquerors and Tribute Bearers	9
79-224	Mayan America	9
79-233	The United States and the Middle East since 1945	9
79-251	India/America: Democracy, Diversity, Development	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
79-292	China Inside Out: Going Global, 19th and 21st Centuries	9
79-295	Race Relations in the Atlantic World	9
79-298	/80-447 Special Topics: Global Justice	9
79-299	Circulation of Children in a Global Context	9
79-312	Cultural Understanding/Misunderstanding: Culture, Histories Janpn Vietm. US Reltn	9
79-383	Epidemic Disease and Public Health	9
79-385	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:

79-226	Introduction to African History I: Earliest Times Origins of the Slave Trades	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	9
79-236	Introduction to African Studies	9
79-290	States/Stateless Societies and Nationalism in West Africa	6
79-291	Globalization in East African History	6
79-386	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:

79-287	Colonization and De-colonization in the Pacific	9
88-411	The Rise of the Asian Economies	9

Europe:

79-202	Flesh and Spirit: Early Modern Europe, 1400-1800	9
79-205	20th Century Europe	9
79-207	Development of European Culture	9
79-213	Nationalities and the New States of the Former USSR	9
79-323	Family Gender and Sexuality in European History, 500-1800	9
82-320	Contemporary Society in German, 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 Peninsular Literature and Culture	9
82-491	Literature, Politics and Film in Russia & East Europe Today	Var.

The Americas:

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
79-235	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
82-454	The Hispanic Caribbean: Rhyme, Reason and Song	9
82-455	Topics in Hispanic Studies	9
82-456	Topics in Hispanic Studies	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 Senior Honors Thesis, for graduating with college-level honors.

Thematic Courses

70-342	Managing Across Cultures	9
70-365	International Trade and International Law	9
76-238	Media and Film Studies	9
76-239	Introduction to Film Studies	9
76-241	Introduction to Gender Studies	9
76-378	Literacy: Educational Theory and Community Practice	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
79-281	Introduction to Religion	9
79-296	Perspectives on Social Protest	9
79-311	Introduction to Anthropology	9
79-314	The Politics and Culture of Memory	9
79-325	Art and Religion	9

79-330	Medicine and Society	9
79-332	Medical Anthropology	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
79-349	The Holocaust in Historical Perspective	9
79-368	Poverty, Charity, and Welfare	9
79-382	History of Biomedical Research	9
79-506	Global Studies Internship	9
80-247	Ethics and Global Economics	9
80-344	Management, Environment, and Ethics	9
82-358	Literacies Across Language and Culture	9
82-384	Language and Culture: Language in its Social Context	9
82-506	Hispanic Studies Internship	Var.
88-205	Comparative Politics	9
88-314	Politics through Film	9
88-357	Comparative Foreign Policy: China, Russia, and the US	9
88-362	Diplomacy and Statecraft	9
88-368	Conflict, Human Rights and Development	9
88-378	International Economics	9
88-384	Conflict and Conflict Resolution in International Relations	9
88-410	The Global Economy: A User's Guide	9
88-412	Economics of Global Warming	9

Nationbased Courses

79-231	/88-329 American Foreign Policy 1945-Present	9
79-245	A History of Asian Americans in the U.S.	9
79-315	Hawaii: America's Pacific Island State	9
82-344	U.S. Latinos: Language and Culture	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, 1978-2008	6
79-309	20th Century China Through Film	9
79-310	Religions of China	9
79-375	China's Environmental Crisis	9
82-333	Introduction to Chinese Language and Culture	Var.
82-433	Topics in Contemporary Culture of China	9
79-258	French History: From the Revolution to De Gaulle	9
82-303	French Culture	9
82-305	French in its Social Contexts	9
79-256	20th Century Germany	9
79-257	Germany and the Second World War	9
82-425	Topics in German Literature and Culture	9
82-426	Topics in German Literature and Culture	9
82-427	Nazi and Resistance Culture	9
82-428	History of German Film	9
79-255	Irish History	9
82-361	Introduction to Italian Culture	9
82-362	Italian Language and Culture	9
82-273	Introduction to Japanese Language and Culture	9
82-278	Japanese Literature in Translation	9
82-473	/474 Topics in Japanese Studies	Var.
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
82-293	Introduction to Russian Culture	9
82-294	Topics in Russian Language and Culture	Var.
82-296	A Century of Russian Film	9
82-342	Spain: Language and Culture	9

VII. Senior Capstone Course (12 units)

79-400	Advanced Seminar in Global Studies	12
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B.A. in Global Studies - Sample Curricula

These sample curricula represent two year plans for completing the requirements for the B.A. in Global Studies, for those students who wish to study abroad and for those who do not wish to do so. Its aim is to show that for almost all students the major can be completed in the last two years of undergraduate study, not that it must be completed according to this schedule. Students may declare the B.A. in Global Studies and take appropriate courses earlier in their academic careers, and should consult frequently with the Global Studies Advisor (see above) about their course of study in Pittsburgh and possibly abroad.

All Students - Freshman or Sophomore Year

Fall	Spring
79-104 Global Histories	79-275 Introduction to Global Studies
Language Course or Gen. Ed.	Language Course or Elective
Gen. Ed. or Elective	Gen. Ed. or Elective
Gen. Ed. or Elective	Gen. Ed. or Elective
Gen. Ed. or Elective	Gen. Ed. or Elective

Students Who Plan to Study Abroad - Junior Year

Fall	Spring (abroad)
G.S. Theoretical/ Topical Core Course	G.S. Transnational, Global, Regional Course
G.S. Transnational, Global, Regional Course	G.S. Elective
Language Course or Elective	Language Course or Elective
Elective	Elective
Elective	Elective

Students Who Plan to Study Abroad - Senior Year

Fall	Spring
G.S. Theoretical/ Topical Core Course	79-400 Advanced Seminar in Global Studies
G.S. Transnational, Global, Regional Course	G.S. Senior Thesis or Elective
G.S. Elective	Language Course or Elective
Language Course or Elective	Elective
Elective	Elective

Students Not Planning to Study Abroad - Junior Year

Fall	Spring
G.S. Theoretical/ Topical Core Course	G.S. Theoretical/ Topical Core Course
G.S. Transnational, Global, Regional Course	G.S. Transnational, Global, Regional Course
Language Course or Elective	G.S. Elective
Elective	Language Course or Elective
Elective	Elective

Students Not Planning to Study Abroad - Senior Year

Fall	Spring
G.S. Transnational, Global, Regional Course	79-400 Advanced Seminar in Global Studies
GS. Elective	G.S. Senior Thesis or Elective
Language Course or Elective	Language Course or Elective
Elective	Elective
Elective	Elective

Additional Major

Global Studies may be elected as a primary or an additional major; the requirements for each are the same. Please 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)

Policy History (9 units)	
79-300 History of Public Policy in the United States	9

U.S. History (9 units)

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)

79-207 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 I: Earliest Times Origins of the Slave Trades	9
79-227 Introduction to African History II: 18th Century to the end of Apartheid	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
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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
80-244 Environmental Ethics	9
80-245 Medical Ethics	9
80-348 Health Development and Human Rights	9
80-447 Global Justice	9

IV. Senior Capstone Project Course 12 units

This course will be co-taught by one member of History and one of Philosophy, and be taken in the fall of the senior year by every student majoring in EHPP. The purpose of the course is to give students a serious opportunity to apply the concepts and knowledge they acquired in the major to single topic, in depth.

IV. 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
70-332 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
73-354 Law And Economics	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
73-371 International Trade and Economic Development	9
73-372 International Money and Finance	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 African American History II	9
79-267 The Soviet Union in World War II: Military, Political and Social History	9
79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations	9
79-289 Energy, Environment, Globalization in the Americas (formerly 79-263, From Soil to Oil: Energy and the Environment in the Americas)	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, 1967 to the Present	9
79-339 The Politics of American Military Recruitment: Historical Perspectives	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
79-342 Introduction to Science and Technology Studies	9

79-368	Poverty, Charity, and Welfare	9
79-371	African American Urban History	9
79-374	American Environmental History: Critical Issues	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
80-242	Conflict and Dispute Resolution	9
80-344	Management, Environment, and Ethics	9
80-341	Computers, Society and Ethics	9
80-344	Management, Environment, and Ethics	9
80-256	Modern Moral Philosophy	9

Social and Decision Sciences

88-104	Decision Processes in American Political Institutions	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
88-358	Policy Making Institutions	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

V. 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, or by petitioning the Director of EHPP to accept equivalent courses as substitutions.

36-202	Statistical Methods <small>(Students may take 36-202 OR 36-208)</small>	9
21-257	Models and Methods for Optimization	9
36-207	Probability and Statistics for Business Applications	9
36-208	Regression Analysis	9
36-303	Sampling, Survey and Society	9
80-305	Rational Choice	9
88-251	Empirical Research Methods	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		Senior Year	
Fall	Spring	Fall	Spring
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective	Elective

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.

Interdepartmental Majors Involving History

In addition to the interdepartmental B.A./B.S. in Ethics, History, and Public Policy (detailed above), co-sponsored with the Philosophy Department, the History Department also co-sponsors the European Studies Major with the Modern Languages Department and the Russian Studies Major with Modern Languages. The History Department also contributes to the International Relations and Politics Major in the Social and Decision Sciences Department.

For further information, please see the H&SS Interdepartmental Majors section.

The Minor in History

The minor in History involves a minimum of 54 units of course work (not including the 9-unit prerequisite), as described below.

Curriculum (minimum) (54 units)

Prerequisite	9
79-104 Global Histories (or equivalent as approved by the Department)	9

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 I: Earliest Times	9
Origins of the Slave Trades	
79-227 Introduction to African History II: 18th Century to the end of Apartheid	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 Ph.D., University of California, San Francisco; Carnegie Mellon, 1993.

SUSAN AMBROSE, Teaching Professor of History; Director, The Eberly Center for Teaching Excellence D.A., Carnegie Mellon University; Carnegie Mellon, 1986.

JAY D. ARONSON, Associate Professor of History Ph.D., University of Minnesota; Carnegie Mellon, 2004.

ALLYSON F. CREASMAN, Assistant 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; Director of Graduate Studies, Department of History Ph.D., University of Pennsylvania; Carnegie Mellon, 1988.

DONNA HARSCH, Professor of History Ph.D., Yale University; Carnegie Mellon, 1990.

KATHERINE A. LYNCH, Professor of History Ph.D., Harvard University; Carnegie Mellon, 1980.

RICHARD MADDOX, Professor of Anthropology and History Ph.D., Stanford University; Carnegie Mellon, 1993.

DAVID W. MILLER, Professor 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 SCHACHTER, Professor of Anthropology and History Ph.D., University of Minnesota; Carnegie Mellon, 1984.

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, 1967.

LISA M. TETRAULT, Associate Professor of History Ph.D., University of Wisconsin; Carnegie Mellon, 2005.

JOE WILLIAM TROTTER, Giant Eagle Professor of History and Social Justice; Head, Department of History Ph.D., University of Minnesota; Carnegie Mellon, 1985.

Adjunct Faculty

SHAWN ALFONSO-WELLS, Adjunct Professor of History Ph.D., University of Pittsburgh; Carnegie Mellon, 2008.

BARBARA BURSTIN, Adjunct Professor of History Ph.D., University of Pittsburgh; Carnegie Mellon, 1993.

JARED DAY, Adjunct Professor of History Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001.

JOSEPH E. DEVINE, Adjunct Professor of History; Associate Dean, College of Humanities and Social Sciences D.A., Carnegie Mellon University; Carnegie Mellon, 1979.

NAUM KATS, Adjunct Professor of History Ph.D., University of Saint Petersburg; Carnegie Mellon, 1990.

MARIE NORMAN, Adjunct Professor of History Ph.D., University of Pittsburgh; Carnegie Mellon, 1998.

The Major in Information Systems

Faculty Program Director: Randy S. Weinberg Office: Porter Hall 222
<http://www.cmu.edu/information-systems/>

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.

Information Systems appeals to outstanding students with a wide range of backgrounds and interests. The major provides students with a broad liberal education (being situated in the College of Humanities & Social Sciences) along with training in the essential aspects of the design and implementation of information systems. The flexible nature of the program encourages students to explore their own interests through optional second majors and minors, program electives and study in a contemporary content area. While all IS majors will become proficient in information technologies, they share a common interest in the effective application of these technologies to real needs for better information management and decision making.

IS students are well prepared to pursue graduate work in a wide range of fields including information systems, business administration, technology management and policy, human-computer interaction and related areas. Some IS students may also position themselves to pursue graduate degrees in social and behavioral sciences or in the humanities. 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, Information Security Policy and Management, Engineering Technology and Innovation Management, and Business Administration. Some of the undergraduate coursework for the IS major can be counted towards graduate requirements and the degree can usually be completed in three or four additional semesters.

IS students meet an important need 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 H&SS General Education Requirements and basic prerequisites in mathematics, statistics and computer programming, IS students must complete a 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. The professional communications area develops skills in the most effective methods for presenting ideas and information.

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. Currently, four content areas are available: (1) Business / Enterprise Systems, (2) Computing and Information Systems & Technology, (3) Global and Social Systems, (4) Research Methods.

Transfer to Information Systems

Most IS students are admitted directly into IS as incoming freshmen. Only Information Systems major students are permitted to enroll in the Professional Core courses, and IS students have enrollment priority in IS electives.

Students in good academic standing may apply to be admitted to the IS 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 will be considered at the end of each semester. Students interested in applying for transfer to the IS major should keep in touch with the IS 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.

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 student advisor to help plan an appropriate course of study.

Additional Major and Minor

Information Systems is not available as either an additional major or minor.

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 all H&SS General Education requirements.

Disclaimer: Requirements are subject to revision. Advisor approval is required for each student's major curriculum plan. IS students may double-count no more than three courses with an additional major, and no more than one course with a minor. No course can count for more than one requirement within the major. Special permission will generally be needed for registration to any course offered by the Heinz College (courses numbered 95-xxx).

Prerequisites

All prerequisites must be successfully completed prior to the start of Fall semester, junior year.

Mathematics and Statistics

Complete any of the following four calculus sequences:

21-111 & 21-112 Calculus I-II	20
or	
21-120 & 21-256 Differential and Integral Calculus - Multivariate Analysis and Approximation	19
or	
21-120 & 21-122 Differential and Integral Calculus - Integration, Differential Equations and Approximation	20
or	
21-121 & 21-123 Integration and Differential Equations - Calculus of Approximation	15

and also complete:

36-201 Statistical Reasoning and Practice	9
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Computer Programming

The courses needed to fulfill this requirement category depend on placement into the appropriate initial programming course from the programming placement test results.

15-110 Principles of Computing	10
15-121 Introduction to Data Structures	10

Professional Core

Complete all six courses:

67-250 The Information Systems Milieux (or 67-344, Organizational Intelligence in the Information Age, used as a substitution for IS transfer students)	9
67-272 Application Design and Development (prerequisites: 67-250 or 67-344 and 15-200 or 15-111)	9
67-371 Fundamentals of System Development I (prerequisites: 67-250 or 67-344 and 15-200 or 15-111)	9
67-373 Software Development Project (prerequisites: 67-271 and 67-272)	12
67-475 Information Systems Applications (prerequisite: 67-373)	12

36 units

Plus one course (6 to 12 units) chosen from one of the following options:

Any advanced Computer Science course (15-2xx or above, not including 15-221).

Any Human-Computer Interaction course (05-xxx).

19-402 Telecommunications, Technology Policy & Management	12
19-601 Information Warfare	12
67-306 Special Topics: Management of Computer and Information Systems	6
67-309 Special Topics	6
67-327 Web Application Security	6
67-328 Distributed Application Development	9
67-329 Contemporary Themes in Global Systems	9
67-330 Technology Consulting in the Community	9
67-331 Technology Consulting in the Global Community	Var.
67-344 Organizational Intelligence in the Information Age	9
67-370 Intelligent Decision Support Systems	9
88-223 Decision Analysis and Decision Support Systems	9

Students may also fulfill this sixth Professional Core course requirement with an approved course from the Heinz College's graduate program in Information Systems Management (95-xxx). Access to these courses are based on approval from the Heinz College. Additionally, other approved courses offered by the Engineering & Public Policy Department (19-xxx) may be used.

Disciplinary Core

Complete one course from each of the three Disciplinary Core categories.

Professional Communications

Information systems professionals communicate with a wide range of people in most organizations and often facilitate communications between diverse groups of stakeholders. Consequently, the most successful professionals typically are those with strong communication skills. These courses help 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):

36-315 Statistical Graphics and Visualization	9
51-261 /262 Communication Design Fundamentals	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 /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
36-208 /70-208 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
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:

19-402 Telecommunications, Technology Policy & Management	12
19-601 Information Warfare	12
67-344 Organizational Intelligence in the Information Age	9
70-311 Organizational Behavior	9
70-341 /88-341 Organizational Communication	9
70-342 Managing Across Cultures	9
80-341 Computers, Society and Ethics	9
88-220 Policy Analysis I	9
88-223 Decision Analysis and Decision Support Systems	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 requirement.

Business/Enterprise Systems

This content area will broaden a student's knowledge in the business, ec

19-402 Telecommunications, Technology Policy & Management	12
19-601 Information Warfare	12
67-301 Networks and Telecommunications	6
67-306 Special Topics: Management of Computer and Information Systems	6
67-309 Special Topics	6
67-330 Technology Consulting in the Community	9
67-331 Technology Consulting in the Global Community	Var.
67-344 Organizational Intelligence in the Information Age	9

67-370	Intelligent Decision Support Systems	9
70-414	Technology Based Entrepreneurship for CIT	9
70-415	Introduction to Entrepreneurship	9
70-455	Information Resource Management	9
70-459	Web Business Engineering	9
70-465	Information Technology Strategy	9
70-471	Logistics and Supply Chain Management	9
70-371	Production/Operations Management	9
73-359	Benefit-Cost Analysis	9
73-469	Global Electronic Markets: Economics and the Internet	9
76-391	Document Design	9
76-487	Online Information Design	9

Students may also apply to this Content area an approved course from the Heinz College's graduate program in Information Systems Management (95-xxx). Access to these courses are based on approval from the Heinz College.

Computing and Information Systems & Technology

This content area allows students to focus on current and emerging technologies.

05-410	Human-Computer Interaction Methods	12
05-430	Programming Usable Interfaces	6
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
15-213	Introduction to Computer Systems	12
15-312	Foundations of Programming Languages	12
16-311	Introduction to Robotics	12
67-327	Web Application Security	6
67-328	Distributed Application Development	9

Students may also apply to this Content area an approved course from the Heinz College's graduate program in Information Systems Management (95-xxx). Access to these courses are based on approval from the Heinz College.

Social and Global Systems

This content area exposes students to key themes in globalization and global systems - management, policy, politics, and technology.

19-402	Telecommunications, Technology Policy & Management	12
19-601	Information Warfare	12
67-329	Contemporary Themes in Global Systems	9
67-330	Technology Consulting in the Community	9
67-331	Technology Consulting in the Global Community	Var.
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
76-318	Communicating in the Global Marketplace	9
79-289	Energy, Environment, Globalization in the Americas	9
88-326	Theories of International Relations	9
88-359	Globalization	9
88-378	International Economics	9
88-384	Conflict and Conflict Resolution in International Relations	9

Students may also apply to this Content area an approved course from the Heinz College's graduate program in Information Systems Management (95-xxx). Access to these courses are based on approval from the Heinz College. Additionally, other approved courses offered by the Engineering & Public Policy Department (19-xxx) may be used.

Quantitative Methods

This area gives students the opportunity to study rigorous analytical methods to support decision making, data analysis, and quantitative reasoning.

21-257	Models and Methods for Optimization	9
36-208 /70-208	Regression Analysis	9
36-303	Sampling, Survey and Society	9
36-350	Data Mining	9
36-401	Modern Regression	9
36-410	Introduction to Probability Modeling	9

36-461	Topics in Statistics	9
70-481	Marketing Research	9
73-261	Econometrics	9
88-223	Decision Analysis and Decision Support Systems	9
88-251	Empirical Research Methods	9

Information Systems, B.S. Sample Curriculum

Freshman Year		Sophomore Year	
Fall	Spring	Fall	Spring
76-101 Interpretation and Argument	79-104 Global Histories	67-250 The Information Systems Milieux	67-272 Application Design and Development
36-201 Statistical Reasoning and Practice	36-202 Statistical Methods	Disciplinary Core Course	Disciplinary Core Course
Calculus Sequence I	Calculus Sequence II	Elective	Elective
15-110 Principles of Computing	15-121 Introduction to Data Structures	Elective	Elective
Computing @ Carnegie Mellon & IS Freshman Workshop	H&SS Freshman Seminar	Elective	Elective
Elective	67-101 Concepts of Information Systems	Elective	Elective

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
67-371 Fundamentals of System Development I	67-373 Software Development Project	67-475 Information Systems Applications	Elective
Professional Core Course	Content Area Course	Content Area Course	Content Area Course
Disciplinary Core Course	Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

Faculty

C.F. LARRY HEIMANN, Teaching Professor Ph.D., Washington University (St. Louis); Carnegie Mellon, 1998.

JERIA QUESENBERRY, Assistant Teaching Professor Ph.D., Pennsylvania State University; Carnegie Mellon, 2007.

RAJA SOORIAMURTHI, 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.

JOSEPH S. MERTZ, Associate Teaching Professor (joint Appointment with Heinz College) Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997.

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 -Yueming Yu, Teaching Professor of Chinese
French & Francophone Studies -Bonnie Youngs, Teaching Professor of French & Francophone Studies
German Studies -Stephen Brockmann, Professor of German
Hispanic Studies -Kenya C. Dworkin y Mendez, Associate Professor of Hispanic Studies
Japanese Studies -Keiko Koda, Professor of Japanese and Second Language Acquisition, and Yasufumi Iwasaki, Assistant Teaching Professor of Japanese
European Studies*- Beryl Schlossman, Professor of 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

	Units
82-232 Intermediate Chinese II **	12
82-331 Advanced Chinese I	9
82-332 Advanced Chinese II	9
82-333 Introduction to Chinese Language and Culture	Var.
	30

* 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:

	Units
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

	Units
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
82-480 Social and Cognitive Aspects of Bilingualism	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: 80-180 The Nature of Language, 85-421 Language and Thought.

* Students may repeat with new topics.

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.

	Units
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

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

	Units
82-337 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.
82-531 /532 Special Topics Chinese	Var.

List B: Chinese Studies Electives (minimum) 9 units

	Units
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
82-439 Modern China Through Literature	Var.
82-440 Studies in Chinese Literature & Culture	9
82-433 Topics in Contemporary Culture of China	9
82-434 Studies in Chinese Traditions *	9
82-436 Introduction to Classical Chinese	9
82-531 /532 Special Topics Chinese	Var.

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.

Architecture	Units
48-351 Human Factors in Architecture	9
48-551 Ethics and Decision Making in Architecture	9
Art	Units
60-373 Aesthetics from a Global Viewpoint	9
60-399 Art History/Theory Independent Study	9
Business	Units
70-342 Managing Across Cultures	9
70-365 International Trade and International Law	9
70-430 International Management	9
English	Units
76-318 Communicating in the Global Marketplace	9
76-339 Advanced Film and Media Studies	9
76-386 Language & Culture	9
76-387 Sociolinguistics	9
History	Units
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
Modern Languages	Units
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
82-480 Social and Cognitive Aspects of Bilingualism	9
Philosophy	Units
80-180 The Nature of Language	9
80-280 Linguistic Analysis	9
80-276 Philosophy of Religion	9
80-380 Philosophy of Language	9
Psychology	Units
85-375 Cross Cultural Psychology	9
85-421 Language and Thought	9
Social and Decision Science	Units
88-357 Comparative Foreign Policy: China, Russia, and the US	9
88-410 The Global Economy: A User's Guide	9
88-411 The Rise of the Asian Economies	9

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		Senior Year	
Fall	Spring	Fall	Spring
82-331 Advanced Chinese I	82-332 Advanced Chinese II	Core Chinese Elective From List A	Core Chinese Elective From List A
82-333 Introduction to Chinese Language and Culture	Core History Course	Chinese Elective From List B or C	Chinese Elective From List B
Core Modern Languages Department Course	Elective	Elective	82-580 Senior Seminar in Modern Languages
Elective	Elective	Elective	Elective
Elective	Elective	Elective	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 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

Complete all three courses.

82-303	French Culture	Units	9
82-304	The Francophone World		9
82-305	French in its Social Contexts		9
			27

2. Core Courses in Modern Languages 12 units

Complete one 9 unit course* plus the Senior Seminar

82-280	Learning About Language Learning	Units	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
82-480	Social and Cognitive Aspects of Bilingualism		9
82-580	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 French or from another department. Examples: 80-180 The Nature of Language, , 85-421 Language and Thought

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

82-401	French Popular Song	Units	9
82-404	Francophone Realities: Africa		9
82-415 /416	Topics in French and Francophone Studies *		9
82-501 /502	Special Topics: French	Var.	
82-505	Undergraduate Internship	Var.	

* 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.

Architecture		Units	
48-340	Modern Architecture and Theory 1900-1945		9
48-341	History of Architectural Theory		9
48-448	History of Sustainable Architecture		9

English		Units	
76-385	Introduction to Discourse Analysis		9
76-386	Language & Culture		9
76-387	Sociolinguistics		9

History		Units	
79-202	Flesh and Spirit: Early Modern Europe, 1400-1800		9
79-205	20th Century Europe		9
79-207	Development of European Culture		9
79-220	Caribbean: Cultures and Histories		9
79-227	Introduction to African History II: 18th Century to the end of Apartheid		9
79-258	French History: From the Revolution to De Gaulle		9
79-275	Introduction to Global Studies		9
79-350	Early Christianity		9
79-385	The Making of the African Diaspora		9
79-386	Entrepreneurs in Africa, Past, Present and Future		9
79-396	Music and Society in 19th and 20th Century Europe and the U.S.		9

Modern Languages		Units	
82-281	Tutoring for Community Outreach	Var.	
82-358	Literacies Across Language and Culture		9
82-380	Independent Study in Second Language Acquisition		9
82-383	Second Language Acquisition: Theories and Research		9
82-384	Language and Culture: Language in its Social Context		9
82-387	The Film Festival		9
82-388	Understanding Second Language Fluency		9
82-480	Social and Cognitive Aspects of Bilingualism		9
82-484	Language Assessment		9
82-487	Writing in a Second Language		9

Music		Units	
57-173	Survey of Western Music History		9
57-306	World Music		6

Philosophy		Units	
80-180	The Nature of Language		9
80-280	Linguistic Analysis		9
80-281	Language and Thought		9
80-380	Philosophy of Language		9

Psychology		Units	
85-375	Cross Cultural Psychology		9
85-421	Language and Thought		9

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

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
82-303 French Culture	82-305 French in its Social Contexts	French Elective From List A	French Elective From List A
82-304 The Francophone World	French Elective From List A	French Elective From List A	French Elective From List A
82-280 Learning About Language Learning	Interdisciplinary Elective From List B	French Elective From List A	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	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 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.

82-320	Contemporary Society in German, Austria and Switzerland	9
82-323	Germany, Austria and Switzerland in the 20th Century	9
82-327	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

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
82-480	Social and Cognitive Aspects of Bilingualism	9
82-580	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 The 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

82-420	German Classical Literature	9
82-421	German Literature of the Nineteenth Century	9
82-422	German Literature of the Early Twentieth Century	9
82-425 /426	Topics in German Literature and Culture *	9
82-427	Nazi and Resistance Culture	9
82-428	History of German Film	9
82-429	German Reading and Translation Workshop: Undergraduate	9
82-521 /522	Independent Study	Var.

* 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.

English		
76-239	Introduction to Film Studies	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
76-483	Corpus Analysis in Rhetoric	9

History		
79-205	20th Century Europe	9
79-208	Europe's Two Revolutions: Dynamics of Change in the 19th Century	9
79-256	20th Century Germany	9
79-257	Germany and the Second World War	9
79-349	The Holocaust in Historical Perspective	9

Modern Languages		
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
82-480	Social and Cognitive Aspects of Bilingualism	9

Music		
57-306	World Music	6

Philosophy		
80-136	Social Structure, Public Policy & Ethics	9
80-180	The Nature of Language	9
80-251	Modern Philosophy	9
80-253	Continental Philosophy	9
80-256	Modern Moral Philosophy	9
80-275	Metaphysics	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9

Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

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

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
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	German Elective From List A
German Elective From List A	German Elective From List A	German Elective From List A	Required Elective From List A or List B
82-280 Learning About Language Learning	Elective	Required Elective From List A or From List B	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
			82-580 Senior Seminar in 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 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

Complete two courses.

82-342	Spain: Language and Culture	9
82-343	Latin America: Language and Culture	9
82-344	U.S. Latinos: Language and Culture	9

Complete required course.

82-345	Introduction to Hispanic Literary and Cultural Studies	9
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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
82-480	Social and Cognitive Aspects of Bilingualism	9
82-580	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 Hispanic Studies or from another department. Examples: 80-180 The Nature of Language, , 85-421 Language and Thought.

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

82-441	Studies in Peninsular Literature and Culture *	9
82-442	Analysis of Spoken Spanish	9
82-443	Spanish Reading and Translation Workshop	9
82-444	The Structure of Spanish	9
82-445	U.S. Latino Literature	9
82-446	Political Drama of Spain	9
82-451	Studies in Latin American Literature and Culture *	9
82-454	The Hispanic Caribbean: Rhyme, Reason and Song	9
82-455 /456	Topics in Hispanic Studies *	9
82-457	Contemporary Latin American Texts: Revision, Rewriting and Representation *	9
82-506	Hispanic Studies Internship	Var.
82-541 /542	Special Topics: Hispanic Studies	Var.

* Students may repeat these courses 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.

English		
76-239	Introduction to Film Studies	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
76-483	Corpus Analysis in Rhetoric	9

History		
79-208	Europe's Two Revolutions: Dynamics of Change in the 19th Century	9
79-220	Caribbean: Cultures and Histories	9
79-221	Development and Democracy in Latin America	9
79-325	Art and Religion	9

Modern Languages		
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
82-480	Social and Cognitive Aspects of Bilingualism	9

Music		
57-306	World Music	6

Philosophy		
80-180	The Nature of Language	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9

Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

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		Senior Year	
Fall	Spring	Fall	Spring
82-342 Spain: Language and Culture	82-345 Introduction to Hispanic Literary and Cultural Studies	Spanish Elective From List A	Spanish Elective From List A
82-343 Latin America: Language and Culture	Interdisciplinary Elective From List B	Spanish Elective From List A	Spanish Elective From List A
82-280 Learning About Language Learning	Elective	Spanish or Interdisciplinary Elective From List A or List B	82-580 Senior Seminar in Modern Languages
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	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.

82-272 Intermediate Japanese II *	12
82-273 Introduction to Japanese Language and Culture	9
82-371 Advanced Japanese I	9
82-372 Advanced Japanese II	9

* Placement out of 82-272 is possible. For students who place out of 82-272, a minimum of 9 additional units must be taken from Category 2 or 4 below.

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
82-480 Social and Cognitive Aspects of Bilingualism	9
82-580 Senior Seminar in Modern Languages	3

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.

79-261 Chinese Culture and Society	9
79-275 Introduction to Global Studies	9
79-280 Experiencing Globalization	9
79-310 Religions of China	9
79-360 Historical Evidence and Interpretation	12

* 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

82-473 /474 Topics in Japanese Studies *	Var.
82-476 Japanese Discourse Analysis	9
82-571 /572 Special Topics: Japanese	Var.

* Students may repeat with new topics.

List B: Interdisciplinary Electives

Electives should be chosen in consultation with the Major Advisor.

English	
76-239 Introduction to Film Studies	9
76-386 Language & Culture	9
76-387 Sociolinguistics	9

History	
79-261 Chinese Culture and Society	9
79-275 Introduction to Global Studies	9
79-280 Experiencing Globalization	9
79-310 Religions of China	9
79-360 Historical Evidence and Interpretation	12

Modern Languages	
82-278 Japanese Literature in Translation	9
82-280 Learning About Language Learning	9
82-281 Tutoring for Community Outreach	Var.
82-358 Literacies Across Language and Culture	9

82-373	Structure of the Japanese Language	9
82-374	Technical Japanese	9
82-383	Second Language Acquisition: Theories and Research	9
82-388	Understanding Second Language Fluency	9
82-480	Social and Cognitive Aspects of Bilingualism	9
Music		
57-306	World Music	6
Philosophy		
80-180	The Nature of Language	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9
Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

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		Senior Year	
Fall	Spring	Fall	Spring
82-273 Introduction to Japanese Language and Culture	Core History Course	Required Elective From List A	Required Elective From List A
Advanced Japanese I	Advanced Japanese II	Required Elective From List A	Required Elective From List B
82-280 Learning About Language Learning	Elective	Elective/ Required Elective From List B	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	82-580 Senior Seminar in 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.

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 or Japanese Studies in addition to their primary major. Non-H&SS students interested in an additional major in Modern Languages need to fulfill only the requirements for the chosen Modern Languages major but not the H&SS General Education program requirements.

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 de-colonization 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.

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 (or demonstrated equivalent) 12
- 82-192 Elementary Russian II (or demonstrated equivalent) 12

4. Core Courses in Modern Languages 27 units

- 82-291 Intermediate Russian 9
- 82-292 Intermediate Russian II 9
- 82-399 Special Topics Russian Var.

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 Literature, Politics and Film in Russia & East Europe Today	Var.
82-491	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		Senior Year	
Fall	Spring	Fall	Spring
82-291	82-292	82-399 Special Topics Russian	82-599 Russian Studies Thesis
Intermediate Russian	Intermediate Russian II	Required Elective	Required Elective
79-265 Russian History: From the First to the Last Tsar	79-265 Russian History: From the First to the Last Tsar	Required Elective	Required Elective
Elective	Required Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

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.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years. 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. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Additional Major

All Russian Studies Program requirements for an additional major are the same as those for students obtaining the major in Russian Studies (B.A.).

Minors in the Department of Modern Languages

In addition to the majors in the Department of Modern Languages, it is also possible to minor in Chinese Studies, European 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** -Yueming Yu, Associate Teaching Professor 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, Assistant Teaching Professor of Hispanic Studies and Therese Tardio, Associate Teaching Professor of Hispanic Studies
- Japanese Studies** - Yasufumi Iwasaki, Assistant Teaching Professor of Japanese Studies and Yoshihiro Yasuhara- Assistant Teaching Professor of Japanese Studies
- European Studies***- Beryl Schlossman, Professor of 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 57-60 units

Prerequisites 0-36 units

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 39 units

Complete four courses.

82-232	Intermediate Chinese II *	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 .

Students who place out of an Intermediate-level Chinese course will need to take an additional 300-level, 9-unit course. Then the total units for this category will be 39 units. Students must choose from the following two courses based on specific needs of each individual student:

82-335	Readings in Chinese	9
82-337	Mandarin Chinese for Oral Communication	9

2. Chinese Studies and Interdisciplinary Electives 18 units

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	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
82-480	Social and Cognitive Aspects of Bilingualism	9

New courses will be added as appropriate.

The Minor in French and Francophone Studies 54 units

Prerequisites 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

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 Electives

82-401	French Popular Song	9
82-404	Francophone Realities: Africa	9
82-407	The Arts in Society	Var.
82-415 /416	Topics in French and Francophone Studies *	9
82-501 /502	Special Topics: French Undergraduate Internship	Var.
82-505	Undergraduate Internship	Var.

* Students may repeat with new topics.

List B. Interdisciplinary Electives

Architecture		
48-340	Modern Architecture and Theory 1900-1945	9
48-341	History of Architectural Theory	9
48-448	History of Sustainable Architecture	9

English		
76-385	Introduction to Discourse Analysis	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
History		
79-202	Flesh and Spirit: Early Modern Europe, 1400-1800	9
79-205	20th Century Europe	9

79-207	Development of European Culture	9
79-220	Caribbean: Cultures and Histories	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	9
79-258	French History: From the Revolution to De Gaulle	9
79-275	Introduction to Global Studies	9
79-350	Early Christianity	9
79-386	Entrepreneurs in Africa, Past, Present and Future	9
79-396	Music and Society in 19th and 20th Century Europe and the U.S.	9
Modern Languages		
82-281	Tutoring for Community Outreach	Var.
82-358	Literacies Across Language and Culture	9
82-380	Independent Study in Second Language Acquisition	9
82-383	Second Language Acquisition: Theories and Research	9
82-384	Language and Culture: Language in its Social Context	9
82-387	The Film Festival	9
82-388	Understanding Second Language Fluency	9
82-480	Social and Cognitive Aspects of Bilingualism	9
82-484	Language Assessment	9
82-487	Writing in a Second Language	9
Music		
57-173	Survey of Western Music History	9
57-306	World Music	6
Philosophy		
80-180	The Nature of Language	9
80-280	Linguistic Analysis	9
80-281	Language and Thought	9
80-380	Philosophy of Language	9
Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9
New courses will be added as appropriate.		

The Minor in German Studies

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 three courses.

82-320	Contemporary Society in German, Austria and Switzerland	9
82-323	Germany, Austria and Switzerland in the 20th Century*	9
82-327	The Emergence of the German Speaking World	9

* A 400-level course may be substituted with an advisor's approval.

2. German Studies & Interdisciplinary Electives

27 units

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

82-420	German Classical Literature	9
82-421	German Literature of the Nineteenth Century	9
82-422	German Literature of the Early Twentieth Century	9
82-425 /426	Topics in German Literature and Culture	9
82-427	Nazi and Resistance Culture	9
82-428	History of German Film	9
82-429	German Reading and Translation Workshop: Undergraduate	9
82-521 /522	Independent Study	Var.

List B. Interdisciplinary Electives

English		
76-239	Introduction to Film Studies	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
76-483	Corpus Analysis in Rhetoric	9

History		
79-205	20th Century Europe	9
79-208	Europe's Two Revolutions: Dynamics of Change in the 19th Century	9

79-256	20th Century Germany	9
79-257	Germany and the Second World War	9
79-349	The Holocaust in Historical Perspective	9

Music		
57-306	World Music	6

Philosophy		
80-136	Social Structure, Public Policy & Ethics	9
80-180	The Nature of Language	9

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80-251	Modern Philosophy	9
80-253	Continental Philosophy	9
80-256	Modern Moral Philosophy	9
80-275	Metaphysics	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9

Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

Additional courses from other departments may be added to list as information becomes available.

The Minor in Hispanic Studies 54 units

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

Complete two courses.

82-342	Spain: Language and Culture	9
82-343	Latin America: Language and Culture	9
82-344	U.S. Latinos: Language and Culture	9

Complete the following course.

82-345	Introduction to Hispanic Literary and Cultural Studies	9
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2. Hispanic Studies and Interdisciplinary Electives 27 units

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

82-441	Studies in Peninsular Literature and Culture	9
82-442	Analysis of Spoken Spanish	9
82-443	Spanish Reading and Translation Workshop	9
82-444	The Structure of Spanish	9
82-445	U.S. Latino Literature	9
82-446	Political Drama of Spain	9
82-451	Studies in Latin American Literature and Culture	9
82-454	The Hispanic Caribbean: Rhyme, Reason and Song	9
82-455 /456	Topics in Hispanic Studies *	9
82-457	Contemporary Latin American Texts: Revision, Rewriting and Representation	9
82-541 /542	Special Topics: Hispanic Studies	Var.

* Students may repeat these courses 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.

English		
76-239	Introduction to Film Studies	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9

History		
79-208	Europe's Two Revolutions: Dynamics of Change in the 19th Century	9
79-222	Between Revolutions: The Development of Modern Latin America	9
79-325	Art and Religion	9

Modern Languages		
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
82-480	Social and Cognitive Aspects of Bilingualism	9

Music		
57-306	World Music	6

Philosophy		
80-180	The Nature of Language	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9

Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

The Minor in Japanese Studies 54-57 units

Prerequisites 0-36 units

Intermediate level proficiency in Japanese. 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 Japanese Studies 27-39 units*

Complete four courses.

82-272	Intermediate Japanese II	12
82-273	Introduction to Japanese Language and Culture	9
82-371	Advanced Japanese I	9
82-372	Advanced Japanese II	9

*Placement out of 82-272 is possible. For students who place out of 82-272, a minimum of 9 additional units must be taken from Category 2 below.

2. Japanese Studies and Interdisciplinary Electives 18 units

In consultation with the Minor Advisor, complete two courses from List A, or one course from List A and one course from List B.

List A. Japanese Studies Electives

82-373	Structure of the Japanese Language	9
82-374	Technical Japanese	9
82-378	Japanese Conversation Analysis	9
82-473 /474	Topics in Japanese Studies *	Var.
82-476	Japanese Discourse Analysis	9
82-571 /572	Special Topics: Japanese	Var.

*Students may repeat with new topics.

List B. Interdisciplinary Electives

English		
76-239	Introduction to Film Studies	9
76-386	Language & Culture	9
76-387	Sociolinguistics	9
History		
79-261	Chinese Culture and Society	9
79-275	Introduction to Global Studies	9
79-280	Experiencing Globalization	9
79-310	Religions of China	9
79-360	Historical Evidence and Interpretation	12
Modern Languages		
82-278	Japanese Literature in Translation	9
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
82-480	Social and Cognitive Aspects of Bilingualism	9
Music		
57-306	World Music	6
Philosophy		
80-180	The Nature of Language	9
80-280	Linguistic Analysis	9
80-380	Philosophy of Language	9
Psychology		
85-375	Cross Cultural Psychology	9
85-421	Language and Thought	9

New courses will be added as appropriate.

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 de-colonization 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

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.

History		
79-205	20th Century Europe	9
79-231	American Foreign Policy 1945-Present	9
79-280	Experiencing Globalization	9
79-281	Introduction to Religion	9
79-282	Europe and the World	9
Modern Languages		
82-392	Advanced Russian II	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	Var.
82-492	The Historical Imagination in Nineteenth-Century Russian Literature	Var.
82-493	Joseph Brodsky in Context	9

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.

KENYA C. DWORKIN Y MENDEZ, Associate Professor of Spanish with courtesy appointments in English and History Ph.D., University of California, Berkeley; Carnegie Mellon, 1993.

GABRIELE EICHMANNS, Assistant Teaching Professor of German Ph.D., University of Washington; Carnegie Mellon, 2008.

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BARBARA FREED, Professor of French and Second Language Acquisition Ph.D., University of Pennsylvania; Carnegie Mellon, 1990.

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ELISABETH KASKE, Assistant Professor of Chinese Ph.D., Heidelberg University; Carnegie Mellon, 2010.

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GIOVANNI PUPPO, Instructor of Italian Ph.D., University of Rome; Carnegie Mellon, 1975.

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NAOKO TAGUCHI, Associate Professor of Japanese and Second Language Acquisition Ph.D., Northern Arizona University; Carnegie Mellon, 2005.

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JAN VAIRO, Senior Lecturer M.A., University of Pittsburgh; Carnegie Mellon, 1992.

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TIANXUE YAO, Senior Lecturer M.A., Carnegie Mellon University, M.A., JiLin University; Carnegie Mellon, 1996.

YOSHIHIRO YASUHARA, Assistant Teaching Professor of Japanese Ph.D., Pennsylvania State University; Carnegie Mellon, 2010.

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

www.hss.cmu.edu/philosophy

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 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)

Policy History (9 units)	
79-300 History of Public Policy in the United States	9

U.S. History (9 units)

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)

79-207 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 I: Earliest Times	9
Origins of the Slave Trades	9
79-227 Introduction to African History II: 18th Century to the end of Apartheid	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
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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.

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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
80-244	Environmental Ethics	9
80-245	Medical Ethics	9
80-348	Health Development and Human Rights	9
80-447	Global Justice	9

IV. Senior Capstone Project Course 12 units

This course will be co-taught by one member of History and one of Philosophy, and be taken in the fall of the senior year by every student majoring in EHPP. The purpose of the course is to give students a serious opportunity to apply the concepts and knowledge they acquired in the major to single topic, in depth.

IV. 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
70-332	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
73-354	Law And Economics	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
73-371	International Trade and Economic Development	9
73-372	International Money and Finance	9
73-476	American Economic History	9

English

76-492	Rhetoric of Public Policy	9
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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	African American History II	9
79-267	The Soviet Union in World War II: Military, Political and Social History	9

79-288	Bananas, Baseball, and Borders: A History of Latin America - US Relations	9
79-289	Energy, Environment, Globalization in the Americas (formerly 79-263, From Soil to Oil: Energy and the Environment in the Americas)	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, 1967 to the Present	9
79-339	The Politics of American Military Recruitment: Historical Perspectives	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
79-342	Introduction to Science and Technology Studies	9
79-368	Poverty, Charity, and Welfare	9
79-371	African American Urban History	9
79-374	American Environmental History: Critical Issues	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
80-242	Conflict and Dispute Resolution	9
80-344	Management, Environment, and Ethics	9
80-341	Computers, Society and Ethics	9
80-344	Management, Environment, and Ethics	9
80-256	Modern Moral Philosophy	9

Social and Decision Sciences

88-104	Decision Processes in American Political Institutions	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
88-358	Policy Making Institutions	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

V. 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, or by petitioning the Director of EHPP to accept equivalent courses as substitutions.

36-202	Statistical Methods <small>(Students may take 36-202 OR 36-208)</small>	9
21-257	Models and Methods for Optimization	9
36-207	Probability and Statistics for Business Applications	9
36-208	Regression Analysis	9
36-303	Sampling, Survey and Society	9
80-305	Rational Choice	9
88-251	Empirical Research Methods	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		Senior Year	
Fall	Spring	Fall	Spring
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective	Elective

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 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 H&SS 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 The Nature of Language 9

Fundamental Skills

Take **one** course from **each** 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

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 9
82-280 Learning About Language Learning 9
82-383 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

Area 2: Discourse, Society and Culture
76-318 Communicating in the Global Marketplace 9
76-385 Introduction to Discourse Analysis 9
76-386 Language & Culture 9
82-273 Introduction to Japanese 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

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 9
76-378 Literacy: Educational Theory and Community Practice 9
76-451 Topics in Language Study 9
76-476 Rhetoric of Science 9
80-281 Language and Thought 9
80-380 Philosophy of Language 9
82-345 Introduction to Hispanic Literary and Cultural Studies 9
82-373 Structure of the Japanese Language 9
82-378 Japanese Conversation Analysis 9
82-388 Understanding Second Language Fluency 9
82-442 Analysis of Spoken Spanish 9
82-444 The Structure of Spanish 9
82-476 Japanese Discourse Analysis 9
82-480 Social and Cognitive Aspects of Bilingualism 9
82-488 Language Learning in a Study Abroad Context 9
80-382 Linguistics of Germanic Languages 9
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

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.

The Major in Logic and Computation

Horacio Arlo-Costa, Director

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 four courses that provide preparation in logic, computer science, mathematics, and statistics: Introduction to Data Structures (15-121), Concepts of Mathematics (21-127), Statistical Reasoning and Practice (36-201), and Logic and Mathematical Inquiry (80-211). This last course is already 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 15-211 / 15-212.

NOTE: Students should complete the prerequisites before their junior year. It is strongly recommended that students take Arguments and Mathematical Inquiry no later than the spring of their sophomore year and, if possible, also Fundamental Data Structures and Algorithms and Principles of Programming. 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 six core courses, four electives, and one seminar. The core courses provide comprehensive background in logic, computability, and analytic philosophy. Logic and Computation (80-310) and Minds Machines, and Knowledge (80-300) 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 the thesis seminar.

Prerequisites 28 units*

15-121	Introduction to Data Structures	10
	or 15-211 Fundamental Data Structures and Algorithms (12 units)	
21-127	Concepts of Mathematics	9
36-201	Statistical Reasoning and Practice	9

Logic and Computation Core 69 units*

80-211	Logic and Mathematical Inquiry	9
80-300	Minds Machines, and Knowledge	9
80-310	Logic and Computation	9
80-311	Computability and Incompleteness	9
80-511	Thesis Seminar	9
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12

* Only 45 units are unique to the major; 15-211 and 15-212 count toward total units for the General Education Program, DCR6, Science and Technology.

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

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
80-383	Language in Use	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
85-412	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 Requirements (min.)		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 back-ground, 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

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 80-100: 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: 80-100

9 units

Area1: 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
80-242	Conflict and Dispute Resolution	9
80-243	Business Ethics	6
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	The Nature of Language	9
80-270	Philosophy of Mind	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	Var.
80-580	Seminar on the Philosophy of Language	9

Area 3: Logic/Philosophy of Mathematics

9 units

80-110	Nature Mathematical Reasoning	9
80-210	Logic and Proofs	9
80-211	Logic and Mathematical Inquiry	9
80-310	Logic and Computation	9
80-311	Computability and Incompleteness	9
80-312	Philosophy of Mathematics	9
80-314	Logic and Artificial Intelligence	9
80-315	Modal Logic	9
80-411	Proof Theory	9
80-413	Category Theory	9
80-513	Seminar on Philosophy of Mathematics	12
80-514	Categorical Logic	9

Area 4: Epistemology/Metaphysics

9 units

One of the following:

80-201	Epistemology	9
80-208	Critical Thinking	9
80-220	Philosophy of Science	9
80-221	Philosophy of Social Science	9
80-226	Revolutions in Science	9
80-300	Minds Machines, and Knowledge	9
80-305	Rational Choice	9
80-321	Causation, Law, and Social Policy	9
80-322	Philosophy of Physics	9
80-323	Philosophy of Biology	9
80-516	Seminar on Causation	Var.
80-520	Seminar on Philosophy Science	9
80-521	Seminar on Methodology	9
80-522	Seminar on the Foundation of Statistics	9

Area 5: History of Philosophy

18 units

Two of the following:

80-250	Ancient Philosophy	9
80-150	Nature of Reason	9
80-226	Revolutions in Science	9
80-251	Modern Philosophy	9
80-253	Continental Philosophy	9
80-254	Analytic Philosophy	9
80-255	Pragmatism	9

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80-256	Modern Moral Philosophy	9
80-257	Nietzsche	9
80-261	Empiricism and Rationalism	9
80-351	Kant	9
80-365	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. A sample Pre-Law program is:

Area 1		
80-235	Political Philosophy	9
Area 2		
80-180	The Nature of Language	9
Area 3		
80-211	Logic and Mathematical Inquiry	9
Area 4		
80-208	Critical Thinking	9
Area 5		
80-150	Nature of Reason	9
80-250	Ancient Philosophy	9
Area 6		
80-242	Conflict and Dispute Resolution	9
80-321	Causation, Law, and Social Policy	9
80-348	Health Development and Human Rights	9
80-447	Global Justice	9

2. For an emphasis on Philosophy of Science a student might take:

Area 1		
80-321	Causation, Law, and Social Policy	9
Area 2		
80-275	Metaphysics	9
Area 3		
80-211	Logic and Mathematical Inquiry	9
Area 4		
80-220	Philosophy of Science	9
	or80-221 Philosophy of Social Science (9 units)	9
Area 5		
80-250	Ancient Philosophy	9
80-226	Revolutions in Science	9
Area 6		
80-150	Nature of Reason	9
80-221	Philosophy of Social Science	9
80-322	Philosophy of Physics	9
80-323	Philosophy of Biology	9

3. For an emphasis on Ethics and Social Philosophy a student might take:

Area 1		
80-230	Ethical Theory	9
Area 2		
80-276	Philosophy of Religion	9
Area 3		
80-110	Nature Mathematical Reasoning	9
Area 4		
80-221	Philosophy of Social Science	9
	or80-321 Causation, Law, and Social Policy (9 units)	9
Area 5		
80-250	Ancient Philosophy	9
Area 6		
80-321	Causation, Law, and Social Policy	9

4. For an emphasis on Philosophy of Mind a student might take:

Area 1		
80-130	Introduction to Ethics	9
Area 2		
80-270	Philosophy of Mind	9
Area 3		
80-211	Logic and Mathematical Inquiry	9
Area 4		
80-201	Epistemology	9
Area 5		
80-251	Modern Philosophy	9

80-351	Kant	9
Area 6		
80-275	Metaphysics	9
80-257	Nietzsche	9
80-300	Minds Machines, and Knowledge	9
80-314	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.

27 units Ethics Core Courses

Complete three courses from any of the following areas with at least two courses at the 200-level or higher.

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
80-242	Conflict and Dispute Resolution	9
80-243	Business Ethics	6
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

18 units Ethics Electives

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.

27 units Logic and Computation Core Courses

80-211	Logic and Mathematical Inquiry	9
	or80-210 Logic and Proofs (9 units)	
80-300	Minds Machines, and Knowledge	9
80-310	Logic and Computation	9
	or80-311 Computability and Incompleteness (9 units)	

27 units Logic and Computation Electives

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.

9 units Logic/Methodology Requirements

Complete one course:

80-110	Nature Mathematical Reasoning	9
80-210	Logic and Proofs	9
80-211	Logic and Mathematical Inquiry	9
80-220	Philosophy of Science	9
80-221	Philosophy of Social Science	9
80-226	Revolutions in Science	9
80-310	Logic and Computation	9
80-311	Computability 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 Philosophy of Mathematics	9
80-514	Categorical Logic	9
80-516	Seminar on Causation	Var.
80-520	Seminar on Philosophy Science	9
80-521	Seminar on Methodology	9
80-522	Seminar on the Foundation of Statistics	9

18 units History of Philosophy Requirements

Complete two courses:

80-250	Ancient Philosophy	9
80-150	Nature of Reason	9
80-226	Revolutions in Science	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
80-351	Kant	9
80-365	Ramsey	9

18 units Philosophy Electives

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 home page: www.hss.cmu.edu/philosophy.

Special Faculty

EFTHYMIOS ATHANASIOU , .

ANDY NORMAN, Ph.D., Northwestern University; .

JOSEPH RAMSEY, Director of Research Computing Ph.D., University of California, San Diego; Carnegie Mellon, 2006.

Faculty

HORACIO ARLO-COSTA, Ph.D., Columbia University; Carnegie Mellon, 1998.

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.

NICOLE HASSOUN, Assistant Professor of Philosophy Ph.D., University of Arizona; Carnegie Mellon, 2007.

KEVIN T. KELLY, Professor of Philosophy Ph.D., University of Pittsburgh; Carnegie Mellon, 1985.

ALEX LONDON, Associate Professor of Philosophy Ph.D., University of Virginia; Carnegie Mellon, 2000.

RICHARD SCHEINES, Professor of Philosophy Ph.D., University of Pittsburgh; Carnegie Mellon, 1987.

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.

PETER L. SPIRITES, 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.

Affiliated Faculty

PETER MADSEN, Ph.D., Duquesne University; .

Emeritus Faculty

DANA S. SCOTT, Hillman University Professor of Mathematical Logic, Computer Science and Philosophy (Emeritus) Ph.D., Princeton University; Carnegie Mellon, 1981.

Adjunct Faculty

THOMAS WERNER, Ph.D., Linguistics, Rutgers University; .

Department of Psychology

Michael Scheier, Department Head
 Department Office: Baker Hall 346-C

<http://www.psy.cmu.edu>

Can newborn infants perceive the world as we do, or is it just "a blooming buzzing confusion"? Do personality, beliefs and social factors influence health? How do scientists make discoveries, and what abilities make these insights possible? How does brain activity reveal differences in thinking? Can computers think the way people do?

These are some of the questions that psychologists at Carnegie Mellon are trying to answer.

For the student who is majoring in Psychology or Cognitive Science, studying with faculty who are on the leading edge of research on questions like the above can be a very exciting experience.

The Psychology Department at Carnegie Mellon has long been noted as one of the pioneering Psychology Departments in the world, particularly in such areas as cognitive psychology, cognitive science, social psychology, developmental psychology, cognitive neuroscience, and health psychology. The Psychology Department offers B.A. and B.S. degrees in Psychology, as well as a B.S. degree in Cognitive Science, and together with the Department of Biological Sciences, a unified B.S. major in Psychology and Biological Sciences.

The Major in Psychology

Psychology is a science which 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 our graduates go on to graduate or professional school. The remainder seek to expand their problem-oriented skills so that job opportunities beyond those typically open to liberal arts students 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 environmental or 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 new state of the art set of undergraduate research laboratories and computer clusters.

In addition to formal class work, students are encouraged to participate in research, project and field work via a number of opportunities available to them. They may register for Independent Reading in Psychology, Independent Research in Psychology, 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 (www.psy.cmu.edu/), Graduate Catalog and Undergraduate Research Brochure provide descriptions of faculty 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. There is also a year long NIMH sponsored internship in mental health research in conjunction with the University of Pittsburgh

Department of Psychiatry. Developmental Internships are available in the department-run CMU Children's School. 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.

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 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 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.

The Department desires that majors acquire breadth in the subject matter of Psychology and that they make informed choices among a set of required area survey courses. The requirement for demonstration of breadth can be met by taking Introduction to Psychology (85-102) and three 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 survey courses.

There are three suggested major tracks starting with the 200-level survey courses. These are cognitive or cognitive-neuroscience, developmental, and social-personality. The tracks are designed to provide increasing depth of knowledge in a particular area of psychology, although the student may as an alternative elect to combine advanced courses from more than one area into a meaningful program.

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. These include a total of 81 units. Advanced courses, which are often in the form of seminars, examine in great depth portions of the three track areas. 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. 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

21-111 & 21-112 Calculus I-II	20
or 21-120 Differential and Integral Calculus (10 units)	
and	
21-256 Multivariate Analysis and Approximation (9 units)	
or 21-120 Differential and Integral Calculus (10 units)	
and	

	21-122 Integration, Differential Equations and Approximation (10 units)	9
36-201	Statistical Reasoning and Practice	9
36-309	Experimental Design for Behavioral and Social Sciences	9

Breadth Requirement 9 units

85-102	Introduction to Psychology *	9
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* 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 or 85-213 Human Information Processing and Artificial Intelligence (9 units)	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
85-340	Research Methods in Social 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.
Any advanced content course or seminar in psychology or any psychology course higher than 85-341. Exceptions: 85-480, 85-482, 85-484, 85-484, 85-506, 85-507, 85-508, 85-601, 85-602, 66-501, 66-502.

Computer Science Requirement 10 units minimum

15-102	Exploring Programming with Graphics	10
	or 15-110 Principles of Computing (10 units)	

Natural Science Requirement (B.A. 18 units, B.S. 36 units)

The Psychology major requires (for B.S. candidates) four 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 two courses 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).

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Survey Course	Survey Course	Advanced Course	Advanced Course
36-309 Experimental Design for Behavioral and Social Sciences	Research Methods Course	Research Methods Course	Elective
Supplementary Science Requirement B.A./B.S.	Supplementary Science Elective for B.S. only	Supplementary Science Elective for B.S. only	Elective
Computer Science Elective	Elective	Elective	Elective

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 sophomore year, and in some instances in the first year. Students should consult their advisors when planning their programs.

Additional Major

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.

Unified Double Major in Psychology & 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 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 Joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Specific 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 HSS or SHS. All other general education categories can be filled in any way that satisfies the requirements of the student's college of the SHS programs.

Mathematical Sciences/Statistics		
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
36-247	Statistics for Lab Sciences *	9
36-309	Experimental Design for Behavioral and Social Sciences	9

* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.

Natural Sciences		
09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
33-xxx	Physics I for Science Students	
09-217	Organic Chemistry I	9
09-218	Organic Chemistry II	9

Computational Reasoning	
99-10x Computing @ Carnegie Mellon	
15-102 Exploring Programming with Graphics	10
or15-110 Principles of Computing (10 units)	

Discipline Core Requirements

Biological Sciences	
03-121 Modern Biology	9
03-231 Biochemistry I	9
03-240 Cell Biology	9
03-330 Genetics	9

Psychology	
85-102 Introduction to Psychology *	9

Complete three of the following courses (85-219 should be included as one of the three):

85-211 Cognitive Psychology	9
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

* NOTE: Students can also take four Survey courses, one of which should be 85-219 Biological Foundations of Behavior.

Laboratory/Research Methods Requirements

09-221 Laboratory I: Introduction to Chemical Analysis	12
09-222 Laboratory II: Organic Synthesis and Analysis	12
03-343 Experimental Techniques in Molecular Biology	12

Research Methods in Psychology

Complete one of the following:

85-310 Research Methods in Cognitive Psychology	9
85-320 Research Methods in Developmental Psychology	9
85-340 Research Methods in Social Psychology	9

Prerequisite for all Research Methods courses: 36-309 , and corresponding psychology survey course.

(Note: 36-309 may be taken concurrently as a co-requisite)

Additional Laboratory Requirement:

Complete one additional laboratory experience either as an additional 85-xxx Research Methods course in Psychology or a second laboratory in Biological Sciences at the 300 level or above.

Advanced Psychology/Biological Sciences Electives: 54 units

1. Psychology Advanced Elective 1
2. Psychology Advanced Elective 2
3. Biology General Elective
4. Biology Advanced Elective 1 (03-362, or 03-363)
5. Biology Advanced Elective 2
6. Advanced Biological Sciences or Psychology Elective, 85-3xx or higher (Research recommended)

See Advanced Courses for details.

Additional comments:

If a student drops the unified major program, a second Research Methods course would be required to complete the B.S. in Psychology. If a student drops the unified major program, the following additional courses would be required to complete the B.S. in Biological Sciences: 09-214 Physical Chemistry, 33-xxx Physics II and a second, 300-level Biology laboratory course.

This program does not satisfy all of the requirements for pre-medical preparation. Advising is suggested to determine the additional courses needed for that program.

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.

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 15-121 Introduction to Data Structures, 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 15-121 and 21-127 early in their program of studies will allow students to move into the 15-211 /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

15-121 Introduction to Data Structures *	10
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Mathematics & Statistics Prerequisites 37-38 units

21-120 & 21-256 Differential and Integral Calculus - Multivariate Analysis and Approximation	19
or21-120 Differential and Integral Calculus (10 units) and 21-122 Integration, Differential Equations and Approximation (10 units)	
21-127 Concepts of Mathematics	9
36-201 Statistical Reasoning and Practice	9
36-309 Experimental Design for Behavioral and Social Sciences	9

Artificial Intelligence Core (minimum) 33 units

15-211 Fundamental Data Structures and Algorithms	12
15-251 Great Theoretical Ideas in Computer Science	12
15-381 Artificial Intelligence: Representation and Problem Solving	9
or85-412 Cognitive Modeling (9 units)	
or85-419 Introduction to Parallel Distributed Processing (9 units)	
or85-426 Learning in Humans and Machines (9 units)	

Cognitive Psychology Core 27 units

85-211 Cognitive Psychology	9
or85-213 Human Information Processing and Artificial Intelligence (9 units)	
85-310 Research Methods in Cognitive Psychology (Prerequisite for all research methods courses 36-309 and corresponding psychology survey course)	9

Plus complete one of the following:

85-412 Cognitive Modeling	9
85-414 Cognitive Neuropsychology	9
85-419 Introduction to Parallel Distributed Processing	9
85-423 Cognitive Development	9
85-426 Learning in Humans and Machines	9

Cognitive Science Concentration Requirement 36 units

Note: The courses to fulfill this requirement should be chosen in collaboration with the student's academic advisor.

Complete four courses from the following course listing. These four courses should be combined into an area of concentration that may include courses from more than one department developed in cooperation with the student's major advisor. As the curriculum evolves, other courses may also be appropriate, and may be selected in consultation with one's psychology faculty advisor.

One example of a concentration area would be cognitive modeling which might involve taking the following: 85-412 Cognitive Modeling, 85-419 Introduction to Parallel Distributed Processing, 85-426 Learning in Humans and Machines, and one other course. Another area might be cognitive neuroscience and could involve four of the following: 85-370 Perception, 03-362 Cellular Neuroscience, 85-414 Cognitive Neuropsychology, 85-419 Introduction to Parallel Distributed Processing, and 85-429 Cognitive Brain Imaging.

Other areas that might be chosen include: human-computer interaction, machine learning, psycholinguistics, perception and natural language processing. Many other possibilities also exist.

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 Human-Computer Interaction Methods	12
05-432 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 Cross Cultural 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
80-300 Minds Machines, and Knowledge	9
80-310 Logic and Computation	9
80-311 Computability 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
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Neurosciences

03-362 Cellular Neuroscience	9
03-363 Systems Neuroscience	9
42-202 Physiology	9
15-386 Neural Computation	9
18-699 /42-590 Special Topics in Signal Processing	12
15-883 Computational Models of Neural Systems	12

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 Functl Organization of the Human Nervous System
- NROSCI1034 Neural Basis of Cognition
- NROSCI1036 Neurobiology of Aging
- NROSCI1040 Biological Basis of Learning and Memory
- NROSCI1041 Developmental Neuroscience
- NROSCI1042 Neurochemical Basis of Behavior

Supplementary Science Requirement (minimum) 18 units

The Cognitive Science program requires two additional science courses (in the same science) 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 33-xxx Physics

* Those interested in a cognitive neuroscience focus are recommended to take biology courses, including if possible, 03-362, or 03-363.

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
15-211 Fundamental Data Structures and Algorithms	15-251 Great Theoretical Ideas in Computer Science	Third Artificial Intelligence Course	Elective
85-211 Cognitive Psychology or 85-213	85-310 Research Methods in Cognitive Psychology	85-412 Cognitive Modeling, 85-419 or 85-423	Elective
36-309 Experimental Design for Behavioral and Social Sciences	Elective	Cognitive Science Breadth Requirement	Cognitive Science Breadth Requirement
Elective	Elective	Elective	Elective

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 a 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 advisors when planning their programs.

Additional Major

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 (15-121),

the Mathematics and Statistics prerequisites, the A.I. Core, The Cognitive Psychology Core, the Cognitive Science Breadth Requirement, and the Supplementary Science Requirement. Students will be assigned a department advisor to help plan their program of studies in Cognitive Science.

The Minor in Psychology

This minor in Psychology is available to all students across the university.

There are three broad areas of concentration in the department, as defined by the three research methods courses together with associated prerequisite survey courses and related advanced courses and seminars.

Curriculum	73 units
I. Introductory course	
85-102 Introduction to Psychology	9
II. Area Survey courses	18
Complete two courses.	
85-211 Cognitive Psychology	9
or 85-213 Human Information Processing and Artificial Intelligence (9 units)	
85-219 Biological Foundations of Behavior	9
85-221 Principles of Child Development	9
85-241 Social Psychology	9
85-251 Personality	9
III. Statistics	19
36-201 Statistical Reasoning and Practice	9
36-309 Experimental Design for Behavioral and Social Sciences	9

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)	
85-310 Research Methods in Cognitive Psychology *	9
85-320 Research Methods in Developmental Psychology *	9
85-340 Research Methods in Social Psychology *	9

* 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 85-341 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.

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.

PATRICIA A. CARPENTER, Lee and Marge Gregg Professor of Psychology Ph.D., Stanford University; Carnegie Mellon, 1972.

SHARON CARVER, Director of Children's School, Teaching Professor of Psychology Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993.

SHELDON COHEN, 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, Assistant Professor Ph.D., The Ohio State University; Carnegie Mellon, 2006.

JOHN R. HAYES, 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, 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, Associate Research 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. SCHEIER, Professor of Psychology, Head, Psychology Department Ph.D., University of Texas; Carnegie Mellon, 1975.

ROBERT S. SIEGLER, 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, Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2009.

ERIK D. THIESSEN, Assistant Professor Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2004.

Department of Social and Decision Sciences

Department Office: Porter Hall 208

<http://www.hss.cmu.edu/sds.html>

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 and Policy and Management, and oversees the International Relations and Politics major offered by the International Relations Program. The majors leverage off of our departmental core that includes courses in decision analysis, empirical research, organizations, and policy analysis. In addition to completing this 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. For example, 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 the 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

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 was the first to offer 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), societal risk management (e.g., assessing and communicating the risks of terrorist attacks), marketing (e.g., understanding the effects of inter-temporal choice 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 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 four clusters: biological and behavioral aspects of decision making, managerial and organizational aspects, philosophical and ethical perspectives, 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.

Mathematics Prerequisite 21-111 & 21-112 Calculus I-II or 21-120 Differential and Integral Calculus (10 units)	Units 20
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	20

Statistics Prerequisite 36-201 Statistical Reasoning and Practice	Units 9
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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.

Disciplinary Perspectives	Units
88-120 Reason, Passion and Cognition **	9
85-211 Cognitive Psychology	9
88-220 Policy Analysis I	9
88-223 Decision Analysis and Decision Support Systems	9
88-302 Behavioral Decision Making	9
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	45

** 88-120 should be taken in the freshman or sophomore year.

Research Methods	Units
36-202 Statistical Methods	9
88-251 Empirical Research Methods	9
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	18

Electives 45 units

Complete 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 selected courses may be from one category or from any combination of categories.

At least two of these courses (18 units) must be Department of Social and Decision Sciences courses (88-xxx).

1. Biological and Behavioral Aspects of Decision Making	Units
85-219 Biological Foundations of Behavior	9
85-241 Social Psychology	9
88-283 Decision Making in Clinical Psychology	9
85-352 Evolutionary Psychology	9
85-355 Introduction to Cognitive Neuroscience	9
85-414 Cognitive Neuropsychology	9
85-442 Health Psychology	9
88-360 Behavioral Economics	9

88-364	Psychobiology and Decision Making	9
88-365	Behavioral Economics and Public Policy	9
88-372	Social and Emotional Brain	9
88-377	Attitudes and Persuasion	9
88-386	Desires and Decisions	9

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 option. Contact the Decision Science faculty director for more information.

2. Managerial and Organizational Aspects of Decision Making		Units
70-332	Business, Society and Ethics	9
70-381	Marketing I	9
70-481	Marketing Research	9
88-221	Policy Analysis II	9
88-222	Policy Analysis III	12
88-341	Organizational Communication	9
88-419	Negotiation	9
88-444	Public Policy and Regulation	9

3. Philosophical and Ethical Perspectives on Decision Making		Units
19-426	Environmental Decision Making	9
80-208	Critical Thinking	9
80-241	Ethical Judgments in Professional Life	9
80-242	Conflict and Dispute Resolution	9
80-305	Rational Choice	9
80-321	Causation, Law, and Social Policy	9

4. Economic and Statistical Methods for Decision Science		Units
73-325	Strategic Behavior in Non-cooperative Games	9
73-347	Game Theory for Economists	9
73-435	Economics of Negotiations	9
80-221	Philosophy of Social Science	9
80-245	Medical Ethics	9
80-337	Philosophy Politics & Economics	9
80-405	Game Theory	9
88-316	Game Theory	9
88-360	Behavioral Economics	9
88-387	Social Norms and Economics	9

* 80-405 and 88-316 are different courses and are not cross-listed.

5. Decision Science and Public Policy		
80-242	Conflict and Dispute Resolution	9
88-221	Policy Analysis II	9
88-222	Policy Analysis III	12
88-365	Behavioral Economics and Public Policy	9
88-412	Economics of Global Warming	9
88-444	Public Policy and Regulation	9

6. Research Methods for Decision Science		Units
36-303	Sampling, Survey and Society	9
85-340	Research Methods in Social Psychology	9
88-252	Empirical Research for Social Science and Policy	9

Note: Some courses have additional prerequisites.

Decision Science, B.S. Sample Curriculum

Freshman or Sophomore Year	Junior Year	
	Spring	Fall
88-120 Reason, Passion and Cognition **	88-220 Policy Analysis I	85-211 Cognitive Psychology
36-202 Statistical Methods	88-251 Empirical Research Methods	88-223 Decision Analysis and Decision Support Systems
Open Prerequisite	88-302 Behavioral Decision Making	Decision Science Elective
Elective	Elective	Elective
Elective	Elective	Elective

Senior Year	
Fall	Spring
Decision Science Elective	Decision Science Elective
Decision Science Elective	Decision Science Elective
Elective or Honors Thesis	Elective or Honors Thesis
Elective	Elective
Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements, with the exception of 88-120 and 36-202. 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 freshman 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.

** This course should be taken as the first course in the Decision Science sequence. It is intended for students in their first or second year; it is offered in Spring semesters. It may be taken as late as the junior year.

Additional Major in Decision Science

Students who elect Decision Science as an additional major must fulfill all of the requirements of the Decision Science major.

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 and 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
 Silvia Borzutzky, Faculty Advisor; sb6n@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 focuses on the role of politics at the national, regional, international, and transnational levels of analysis. The major examines political arrangements within and among each of these levels and investigates the phenomenon known as 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 defines globalization as the intersection of international politics, culture, markets, and technology. IRP also investigates how states construct grand strategy and examines the role of grand strategy in the international system. Once again reflecting Carnegie Mellon's emphasis on interdisciplinary research, the IRP major approaches the study of grand strategy from the intersection of history, politics, economics, and technological change.

No single discipline can fully grapple with what it means to live in a global society, understand the full complement of political interactions that affect the international system, or develop a grand strategy that addresses all state and non-state challenges as well as the interdependence of domestic and international politics. The IRP major is rooted in the discipline of political science and relies upon analytical social science for important insights into globalization, international politics, and grand strategy. To this end, this major makes use of the intellectual strengths of the Department of Social and Decision Sciences, which include behavioral decision science, economics, complex social systems, and the program in strategy, entrepreneurship, and technological change. Understanding of globalization, international politics, and grand strategy is further informed by courses and colloquia offered by Carnegie Mellon'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, those 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 (CMU/WSP) allows students to study public policy and intern in Washington for one semester. Courses taken through the CMU/WSP will count toward requirements in the elective sequence for IRP majors.

IRP majors are encouraged to join the International Relations Organization (IRO) on campus, which sponsors the Model UN, and other student organizations focused on domestic or international politics. Students should also consider 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 IRP Program and SDS.

The International Relations and Politics major is offered through the Department of Social and Decision Sciences. It is available as both a primary major and an additional major in the 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.

Mathematics and Statistics Prerequisites	Units
21-111 & 21-112 Calculus I-II	10-20
or 21-120 Differential and Integral Calculus (10 units)	
36-201 Statistical Reasoning and Practice	9
	19-29

Curriculum

Core Courses	Units
36-202 Statistical Methods	9
88-104 Decision Processes in American Political Institutions	9
88-205 Comparative Politics	9
88-220 Policy Analysis I	9
88-251 Empirical Research Methods	9
88-326 Theories of International Relations	9
	<hr/> 54

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

45-48 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 (CMU/WSP) Public Policy elective sequence (48 units). Any elective units not fulfilled during CMU/WSP may be completed through coursework from the International Political Economy, International Politics and Grand Strategy, and International Cultures elective lists.

The Washington Semester Program (CMU/WSP) Public Policy Elective Sequence includes: • Internship (12 units) • Seminar (24 units) • Research Project (12 units)

International Political Economy	Units
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
79-298 /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
88-368 Conflict, Human Rights and Development	9
88-378 International Economics	9
88-410 The Global Economy: A User's Guide	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, and Policy in the US 1776-2076	9
88-415 Global Competitiveness: Firms Nations, and Technological Change	9
88-419 Negotiation	9
88-423 Institutions, Entrepreneurship, and Innovation	9

International Politics and Grand Strategy	Units
19-609 Public Policy and Regulation	9
80-135 Introduction to Political Philosophy	9
80-235 Political Philosophy	9
80-242 Conflict and Dispute Resolution	9
80-321 Causation, Law, and Social Policy	9
88-314 Politics through Film	9
88-329 /79-231 American Foreign Policy: 1945-Present	9
88-357 Comparative Foreign Policy: China, Russia, and the US	9
88-358 Policy Making Institutions	9
88-359 Globalization	9

88-362	Diplomacy and Statecraft	9
88-370	African Politics	9
88-384	Conflict and Conflict Resolution in International Relations	9
88-423	Institutions, Entrepreneurship, and Innovation	9
International Cultures		Units
300-level	language course (at most one for this category)	
70-342	Managing Across Cultures	9
76-318	Communicating in the Global Marketplace	9
76-386	Language & Culture	9
79-205	20th Century Europe	9
79-222	Between Revolutions: The Development of Modern Latin America	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
79-224	Mayan America	9
79-227	Introduction to African History II: 18th Century to the end of Apartheid	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
79-282	Europe and the World	9
79-259	France During World War II	9
79-261	Chinese Culture and Society	9
79-263	China's Cultural Revolution	6
79-264	China in the Age of Reform, 1978-2008	6
79-265	Russian History: From the First to the Last Tsar	9
79-262	Modern China	9
79-267	The Soviet Union in World War II: Military, Political and Social History	9
79-275	Introduction to Global Studies	9
79-266	Russian History: From Communism to Capitalism	9
79-280	Experiencing Globalization	9
79-286	Gandhi and King: Nonviolent Leadership in a Globalized World	9
79-287	Colonization and De-colonization in the Pacific	9
79-289	Energy, Environment, Globalization in the Americas	9
79-257	Germany and the Second World War	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 and 21st Centuries	9
79-299	Circulation of Children in a Global Context	9
79-307	Religion and Politics in the Middle East	9
79-309	20th Century China Through Film	9
79-288	Bananas, Baseball, and Borders: A History of Latin America - US Relations	9
79-334	Law, Ethics, and the Life Sciences	9
79-385	The Making of the African Diaspora	9
79-368	Poverty, Charity, and Welfare	9
79-314	The Politics and Culture of Memory	9
79-377	Food, Culture, and Power: A History of Eating	9
79-375	China's Environmental Crisis	9
79-383	Epidemic Disease and Public Health	9
79-392	History of Modern Warfare	9
79-398	Documenting the 1967 Arab-Israeli War	9
79-399	US-Arab Encounters	9
79-342	Introduction to Science and Technology Studies	9
82-320	Contemporary Society in German, Austria and Switzerland	9
82-304	The Francophone World	9
82-323	Germany, Austria and Switzerland in the 20th Century	9
82-333	Introduction to Chinese Language and Culture	Var.
82-342	Spain: Language and Culture	9
82-344	U.S. Latinos: Language and Culture	9
82-343	Latin America: Language and Culture	9
82-361	Introduction to Italian Culture	9
82-362	Italian Language and Culture	9
82-345	Introduction to Hispanic Literary and Cultural Studies	9
82-426	Topics in German Literature and Culture	9
82-404	Francophone Realities: Africa	9
82-441	Studies in Peninsular Literature and Culture	9
82-451	Studies in Latin American Literature and Culture	9

82-455	Topics in Hispanic Studies	9
82-474	Topics of Japanese Studies	9
82-491	Literature, Politics and Film in Russia & East Europe Today	Var.
85-375	Cross Cultural Psychology	9

NOTE: Some courses have additional prerequisites.

International Relations and Politics, B.S.

Sample curriculum. Students planning to participate in the Washington Semester Program or in a study abroad program should discuss their course plan with the academic advisor.*

Freshman or Sophomore Year	
Fall	Spring
88-104 Decision Processes in American Political Institutions**	36-202 Statistical Methods
Open Prerequisite	Open Prerequisite
82-xxx (Elementary I language course)	82-xxx (Elementary II language course)
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
88-251 Empirical Research Methods	IRP Elective	88-205 Comparative Politics	88-326 Theories of International Relations
88-220 Policy Analysis I	IRP Elective	IRP Elective	Elective or Honors Thesis
IRP Elective	82-xxx (Intermediate II language course)	IRP Elective	Elective
82-xxx (Intermediate I language course)	Elective	Elective or Honors Thesis	Elective
Elective	Elective	Elective	Elective

* This is presented as a two-year (junior-senior) plan for completing major requirements, with the exceptions of 88-104 and 36-202. 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 freshman year. All students are strongly encouraged to participate in the CMU/WSP (preferably during spring semester of the junior year) and/or in a study abroad program. Students should consult their advisor when planning their program.

**This course should be taken as the first course in the International Relations and Politics sequence. It is intended for students in their first or second years.

Additional Major

Students who elect International Relations and Politics as part of 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 Office: Porter Hall 208A

The Policy and Management major prepares students for key decision-making and management roles in government, the non-profit sector, and business. The major emphasizes analytic approaches to decision making, management, and organization, and combines such knowledge with the practical 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 dangers 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.

Mathematics Prerequisites	Units
21-111 & 21-112 Calculus I-II	20
or 21-120 Differential and Integral Calculus (10 units)	
21-122 Integration, Differential Equations and Approximation	10
or 21-256 Multivariate Analysis and Approximation (9 units)	
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	30
Statistics Prerequisite	Units
36-201 Statistical Reasoning and Practice	9
	<hr/>
	9

Curriculum

111 units

Analytical Methods	Units
88-220 Policy Analysis I	9
88-221 Policy Analysis II	9
88-222 Policy Analysis III	12
88-223 Decision Analysis and Decision Support Systems	9
	<hr/>
	39
Organizational Context	Units
88-260 Organizations	9
	<hr/>
	9
Research Methods	Units
36-202 Statistical Methods	9
88-251 Empirical Research Methods	9
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	18

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).

1. Policy Making	Units
73-340 Labor Economics	9
73-352 Public Economics	9
73-357 Regulation: Theory and Policy	9
73-420 Monetary Theory and Policy	9
79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967	9
79-306 Delinquency, Crime and Juvenile Justice, 1967 to the Present	9
79-329 History of Feminist Theory	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
88-202 History of Public Policy in the United States	9
88-346 Environmental History and Politics Since Silent Spring	9
88-358 Policy Making Institutions	9
88-365 Behavioral Economics and Public Policy	9
88-412 Economics of Global Warming	9
88-423 Institutions, Entrepreneurship, and Innovation	9
88-444 Public Policy and Regulation	9
2. Management	Units
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
80-242 Conflict and Dispute Resolution	9
80-243 Business Ethics	6
80-244 Environmental Ethics	9
80-344 Management, Environment, and Ethics	9
88-252 Empirical Research for Social Science and Policy	9
88-341 Organizational Communication	9
88-343 Economics of Technological Change	9
88-360 Behavioral Economics	9
88-385 Managerial Decision Making	9
88-387 Social Norms and Economics	9
88-419 Negotiation	9
3. Technology and Information	Units
19-402 Telecommunications, Technology Policy & Management	12
19-448 Science, Technology & Ethics	9
73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property	9
79-230 Arab-Israeli Conflict and Peace Process since 1948	9
79-340 Who Shall Play? Gender and Race in American Sport	9
79-342 Introduction to Science and Technology Studies	9
80-341 Computers, Society and Ethics	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
88-391	Technology and Economic Growth	9
88-413	Energy and Climate: History, Science, Technology, and Policy in the US 1776-2076	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
79-289	Energy, Environment, Globalization in the Americas	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
88-378	International Economics	9
88-370	African Politics	9
88-384	Conflict and Conflict Resolution in International Relations	9
88-410	The Global Economy: A User's Guide	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
79-334	Law, Ethics, and the Life Sciences	9
80-235	Political Philosophy	9
80-242	Conflict and Dispute Resolution	9
80-321	Causation, Law, and Social Policy	9
88-181	Topics in Law: 1st Amendment *	9
88-184	Topics of Law: The Bill of Rights *	9
73-354	Law And Economics	9
88-202	History of Public Policy in the United States	9
88-346	Environmental History and Politics Since Silent Spring	9
88-358	Policy Making Institutions	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 major.

NOTE: Some courses have additional prerequisites.

Policy and Management, B.S. Sample Curriculum

Freshman or Sophomore Year	Junior Year	
Spring	Fall	Spring
36-202 Statistical Methods	88-220 Policy Analysis I	88-221 Policy Analysis II
Open Prerequisite	88-251 Empirical Research Methods	88-223 Decision Analysis and Decision Support Systems
Open Prerequisite	Elective	88-260 Organizations
Elective	Elective	Elective
Elective	Elective	Elective

Senior Year	
Fall	Spring
88-222 Policy Analysis III	88-222 Policy Analysis III or P&M Elective
Policy and Management Elective	Policy and Management Elective
Policy and Management Elective	Policy and Management Elective
Elective	Elective
Elective	Elective

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 Innovation, Entrepreneurship, and Economic Development

Serguey Braguinsky, Faculty Director Emily Half, Academic Advisor; ehalf@andrew.cmu.edu, Baker Hall A60C, 412-268-7082

The pace of technological change has been steadily increasing over the last 100 to 200 years, if not longer. The ability of nations to grow and prosper economically is dependent on their ability to harness the forces of technological change. Today it is common to speak of the knowledge economy in which the success of firms depends on their ability to manage innovation and technological change. Regions all aspire to be the next Silicon Valley and enact all kinds of policies to lure and support innovative firms. Technological change pervades our lives, entering nearly every decision we make. The goal of the minor in Innovation, Entrepreneurship, and Economic Development (IEE) is to equip students to understand the forces underlying and unleashed by technological change in order to become better decisionmakers, managers, policy analysts, and researchers. IEE is available to undergraduate students in all colleges.

This interdisciplinary and interdepartmental minor, composed of courses offered in various departments and colleges throughout the university, is offered through the International Relations and Politics Program and the Department of Social and Decision Sciences, in the College of Humanities and Social Sciences.

In order to complete the minor, students must take six courses: two core courses, and four electives. At most one of these courses may double-count with another major or minor.

Curriculum	54 units
Required Courses	18 units
At least two of the courses must come from the following list of core courses:	
Core Courses	
70-416 New Venture Creation	9
70-418 Financing Entrepreneurship Ventures	9
73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property	9
79-342 Introduction to Science and Technology Studies	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
88-391 Technology and Economic Growth	9
88-410 The Global Economy: A User's Guide	9
88-411 The Rise of the Asian Economies	9
88-413 Energy and Climate: History, Science, Technology, and Policy in the US 1776-2076	9
	36 units

Electives

The other four required courses can come from the above list of core courses or the following courses that were developed in whole or part for the minor:

Elective Courses	
08-463 Service Innovation	6
08-533 Privacy, Policy, Law and Technology	9
15-390 Entrepreneurship for Computer Science	9
19-402 Telecommunications, Technology Policy & Management	12
19-448 Science, Technology & Ethics	9
19-609 Public Policy and Regulation	9
24-484 Decision Tools for Engineering Design and Entrepreneurship	12
60-540 The Artist as Entrepreneur	3
73-148 Environmental Economics	9
73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property	9
79-246 Industrial America	9
79-289 Energy, Environment, Globalization in the Americas	9
79-334 Law, Ethics, and the Life Sciences	9
79-372 Perspectives on the Urban Environment	9
79-386 Entrepreneurs in Africa, Past, Present and Future	9
88-378 International Economics	9
88-412 Economics of Global Warming	9
88-415 Global Competitiveness: Firms Nations, and Technological Change	9
88-419 Negotiation	9
88-423 Institutions, Entrepreneurship, and Innovation	9

Students can also nominate up to two courses outside of the above two lists to qualify toward the six courses required for the minor. These courses must be directly relevant to the minor. A student must submit and have approved a petition for a course outside the above lists to qualify for the minor.

NOTE: Some courses have additional prerequisites.

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 to 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.

Curriculum	54 units
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
73-340 Labor Economics	9
73-352 Public Economics	9
73-357 Regulation: Theory and Policy	9
73-420 Monetary Theory and Policy	9
79-305 Juvenile Delinquency: Images, Realities, Public Policy, 1800-1967	9
79-306 Delinquency, Crime and Juvenile Justice, 1967 to the Present	9
79-329 History of Feminist Theory	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
88-202 History of Public Policy in the United States	9
88-346 Environmental History and Politics Since Silent Spring	9
88-358 Policy Making Institutions	9
88-365 Behavioral Economics and Public Policy	9
88-412 Economics of Global Warming	9
88-423 Institutions, Entrepreneurship, and Innovation	9
88-444 Public Policy and Regulation	9
2. Management	Units
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
80-242 Conflict and Dispute Resolution	9
80-243 Business Ethics	6
80-244 Environmental Ethics	9
80-344 Management, Environment, and Ethics	9
88-252 Empirical Research for Social Science and Policy	9
88-341 Organizational Communication	9
88-343 Economics of Technological Change	9
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88-345 Perspectives on Industrial Research and Development	9
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88-371 Entrepreneurship, Regulation and Technological Change	9

88-391	Technology and Economic Growth	9
88-413	Energy and Climate: History, Science, Technology, and Policy in the US 1776-2076	9
88-415	Global Competitiveness: Firms Nations, and Technological Change	9
4. International Policy		
79-278	Rights to Representation: Indigenous People and their Media	9
79-280	Experiencing Globalization	9
79-289	Energy, Environment, Globalization in the Americas	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
88-378	International Economics	9
88-370	African Politics	9
88-384	Conflict and Conflict Resolution in International Relations	9
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88-411	The Rise of the Asian Economies	9
88-412	Economics of Global Warming	9
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70-365	International Trade and International Law	9
79-334	Law, Ethics, and the Life Sciences	9
80-235	Political Philosophy	9
80-242	Conflict and Dispute Resolution	9
80-321	Causation, Law, and Social Policy	9
88-181	Topics in Law: 1st Amendment *	9
88-184	Topics of Law: The Bill of Rights *	9
73-354	Law And Economics	9
88-202	History of Public Policy in the United States	9
88-346	Environmental History and Politics Since Silent Spring	9
88-358	Policy Making Institutions	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 major.

NOTE: Some courses have additional prerequisites.

Faculty

LINDA BABCOCK, James Mellon Walton Professor of Economics Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 1988.

SILVIA BORZUTZKY, Teaching Professor of Political Science and International Relations Ph.D., University of Pittsburgh; Carnegie Mellon, 2001.

SERGUEY BRAGUINSKY, Associate Professor Ph.D., Keio University, Japan; Carnegie Mellon, 2008.

LEE BRANSTETTER, Associate Professor Ph.D., Harvard University; Carnegie Mellon, 2006.

WÁ*NDI BRUINE DE BRUIN, Assistant Professor Ph.D., Carnegie Mellon; Carnegie Mellon, 2009.

JULIE DOWNS, Assistant 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, 2009.

RUSSELL GOLMAN, Visiting 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 GREENSTREET, Assistant Professor Ph.D., The University of Michigan; Carnegie Mellon, 2008.

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.

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CAREY MOREWEDGE, Assistant Professor Ph.D., Harvard University; Carnegie Mellon, 2007.

KIRON K. SKINNER, Associate Professor of International Relations and Political Science Ph.D., Harvard University; Carnegie Mellon, 1999.

GOLNAZ TABIBNIA, Assistant Professor Ph.D., University of California, Los Angeles; Carnegie Mellon, 2009.

ROBERTO A. WEBER, Professor of Social and Decision Sciences Ph.D., California Institute of Technology; Carnegie Mellon, 1999.

ERTE XIAO, Assistant Professor Ph.D., George Mason University; Carnegie Mellon, 2008.

Faculty by Courtesy Appointment

LINDA ARGOTE, David and Barbara Kirr 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.

JOACHIM VOSGERAU, Assistant Professor of Marketing Ph.D., INSEAD, France; Carnegie Mellon, 2007.

Emeriti Faculty

ROBYN DAWES, Ph.D., The University of Michigan; Carnegie Mellon, 1985.

WILLIAM R. KEECH, Ph.D. University of Wisconsin-Madison; Carnegie Mellon, 1997.

Department of Statistics

Mark J. Schervish, Department Head Ken Pawlik, Academic Coordinator
 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 Intel, Proctor and Gamble, Price Waterhouse-Coopers, D.E. Shaw, Harvard Management Company, and Marketing and Planning Systems. Other students have been taken research positions at the National Security Agency, the Census Bureau, and internships at the Joint Program in Survey Methodology in Washington D.C. and the Epidemiology Data Center at the University of Pittsburgh. Many of our students have also gone on to graduate study at some of the top programs in the country, including Statistics at Carnegie Mellon, Yale, and the University of Washington; Biostatistics at Michigan, Harvard and Johns Hopkins; Industrial Engineering at Stanford; Operations Research at Penn State; and Clinical Psychology and Neuroscience at the University of Pittsburgh.

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 firmly dedicated to 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.
- Many exciting Research Projects are ongoing in the Statistics Department, 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 a good way to get involved in cutting-edge research within the Statistics Department.

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. This is 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.

The Major in Statistics (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

21-111	Calculus I	10
21-112	Calculus II	10

and one of the following:

21-256	Multivariate Analysis and Approximation	9
21-259	Calculus in Three Dimensions	9

Sequence 2

21-120	Differential and Integral Calculus	10
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and one of the following:

21-256	Multivariate Analysis and Approximation	9
21-259	Calculus in Three Dimensions	9

Note: Other sequences are possible, and require approval from the undergraduate advisor.

Linear Algebra** : Complete *one* of the following two courses:

21-241	Matrix Algebra	9
21-341	Linear Algebra ***	9

* It is recommended that students complete the calculus requirement during their freshman year.

**The linear algebra requirement needs to be completed before taking 36-401

***This is a more mathematically rigorous course that is usually taken only by mathematics majors

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&SS 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 /70-207	Probability and Statistics for Business Applications	9
36-220	Engineering Statistics and Quality Control	9
36-247	Statistics for Lab Sciences	9

* Students who enter the program through 36-225 or 36-226 (like math or CS majors choosing statistics as an additional major), usually skip the beginning data analysis course and take an additional statistics elective instead (see category #5, Statistical Electives, below)

Intermediate Choose *one* of the following courses

36-202	Statistical Methods	9
36-208	Regression Analysis (cross listed as 70-208)	9
36-309	Experimental Design for Behavioral and Social Sciences	9

Advanced Choose *one* of the following three courses:

36-303	Sampling, Survey and Society	9
36-315	Statistical Graphics and Visualization	9
36-350	Data Mining	9

and take the following two courses:

36-401	Modern Regression	9
36-402	Advanced Data Analysis	9

3. Probability Theory and Statistical Theory: 18 units

The theory of probability gives a mathematical description of the randomness inherent in our observations. It is the language in which statistical models are stated, so an understanding of probability is essential for the study of statistical theory. Statistical theory provides a mathematical framework for making inferences about unknown quantities from data. The theory reduces statistical problems to their essential ingredients to help devise and evaluate inferential procedures. It provides a powerful and wide-ranging set of tools for dealing with uncertainty.

To satisfy the theory requirement take the following two courses*:

36-225	Introduction to Probability Theory **	9
36-226	Introduction to Probability and Statistics II	9

* A grade of C or better is required to continue from 36-225 to 36-226 .

**It is possible to substitute 36-217 or 21-325 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 36-226. In particular, a grade of C or higher in 36-226 is required in order to be able to continue to senior level courses (such as 36-401).

(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, which is a 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 seminar courses that focus on specific statistical applications or advanced statistical methods. These courses are numbered 36-46x (36-461, 36-462, etc.). At least one of these courses will be offered every year, but usually one will be offered every semester. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, statistical genetics, and statistical methods in epidemiology. The objective of the seminar 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 have 36-401 as a prerequisite.

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.

15-102	Exploring Programming with Graphics	10
15-110	Principles of Computing	10
15-122	Principles of Imperative Computation	10
15-123	Effective Programming in C and UNIX	9
15-212	Principles of Programming	12
21-127	Concepts of Mathematics	9
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-292	Operations Research I	9
21-301	Combinatorics	9
80-220	Philosophy of Science	9
80-221	Philosophy of Social Science	9
80-310	Logic and Computation	9
85-310	Research Methods in Cognitive Psychology	9
85-340	Research Methods in Social Psychology	9
88-223	Decision Analysis and Decision Support Systems	9
88-302	Behavioral Decision Making	9

Note: Additional prerequisites are required for some of these courses. Students should carefully check the course descriptions to determine if additional prerequisites are necessary.

* 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 to take *two* electives only one of which can be outside the Statistics Department.

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:	360

* 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.

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 prerequisite or when many of the other major's requirements overlap with the requirements for a Major in Statistics.

Any issue related to **double counting** should be discussed with a Statistics Advisor.

Research

One goal of the Statistics program is to give students experience with statistical research. A wide variety of exciting research projects is ongoing in the department, and students have many opportunities to get involved in a project that interests them.

Before graduation students are encouraged to participate in an independent research project under faculty supervision. Students do this through projects in specific courses, such as 36-303 , through an independent study, or through a summer research position.

Qualified seniors are also encouraged to participate in an advanced research project 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 (see relevant section in the catalog for details).

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 as a Statistical Elective outside of Statistics.

The second schedule is an example of the case when a student enters the program through 36-225 and 36-226 (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 Statistics Department. This schedule has more emphasis on statistical theory and probability.

In both schedules, C.A. refers to Concentration Area courses.

Schedule 1

Freshman		Sophomore	
Fall	Spring	Fall	Spring
36-201 Statistical Reasoning and Practice	36-202 Statistical Methods	21-127 Concepts of Mathematics	36-315 Statistical Graphics and Visualization
21-111 Calculus I	21-112 Calculus II	21-256 Multivariate Analysis and Approximation	

Junior		Senior	
Fall	Spring	Fall	Spring
36-225 Introduction to Probability Theory	36-226 Introduction to Probability and Statistics II	36-401 Modern Regression	36-402 Advanced Data Analysis
21-241 Matrix Algebra	C.A.	C.A.	36-463 Topics in Statistics
C.A.			C.A.

Schedule 2

Freshman		Sophomore	
Fall	Spring	Fall	Spring
21-120 Differential and Integral Calculus	21-256 Multivariate Analysis and Approximation	36-225 Introduction to Probability Theory	36-226 Introduction to Probability and Statistics II
			21-241 Matrix Algebra

Junior		Senior	
Fall	Spring	Fall	Spring
36-350 Data Mining	36-315 Statistical Graphics and Visualization	36-401 Modern Regression	36-402 Advanced Data Analysis
36-309 Experimental Design for Behavioral and Social Sciences	36-410 Introduction to Probability Modeling	C.A.	36-462 Topics in Statistics
C.A.	C.A.		C.A.

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) with 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 (read the section about the Major in Statistics for details):

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 the major	82 Units
-----------------------------------------------------	-----------------

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

Freshman		Sophomore	
Fall	Spring	Fall	Spring
21-111 Calculus I	21-112 Calculus II	21-256 Multivariate Analysis and Approximation	21-241 Matrix Algebra
36-201 Statistical Reasoning and Practice		36-309 Experimental Design for Behavioral and Social Sciences	

Junior		Senior	
Fall	Spring	Fall	Spring
36-225 Introduction to Probability Theory	36-226 Introduction to Probability and Statistics II	36-401 Modern Regression	36-402 Advanced Data Analysis

Schedule 2

Freshman		Sophomore	
Fall	Spring	Fall	Spring
21-120 Differential and Integral Calculus	21-256 Multivariate Analysis and Approximation	36-225 Introduction to Probability Theory	36-226 Introduction to Probability and Statistics II

Junior		Senior	
Fall	Spring	Fall	Spring
21-241 Matrix Algebra	36-315 Statistical Graphics and Visualization	36-401 Modern Regression	36-402 Advanced Data Analysis

The Major in Economics and Statistics (B.S. in Economics and Statistics)

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 84 Units

1. Writing Prerequisite 9 units

73-270 Writing for Economists 9

2. Mathematical Foundations 38 units

21-120 Differential and Integral Calculus 10
 21-259 Calculus in Three Dimensions 9
 21-122 Integration, Differential Equations and Approximation 10
 21-241 Matrix Algebra 9

9 units

3. Economics Foundations

73-100 Principles of Economics 9

4. Statistical Foundations 18 units

36-201 Statistical Reasoning and Practice * 9

and one of the following:

36-202 Statistical Methods 9
 36-208 Regression Analysis (cross listed as 70-208) 9
 36-309 Experimental Design for Behavioral and Social Sciences 9

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247, and 70-207

5. Programming prerequisite 10 units

15-110 Principles of Computing 10

II. Disciplinary Core 111 units

1. Economics Core 39 units

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

* Mini courses

2. Statistics Core 36 units

36-225 Introduction to Probability Theory * 9
 36-226 Introduction to Probability and Statistics II ** 9
 36-401 Modern Regression 9
 36-402 Advanced Data Analysis (Project Course) 9

* A grade of C or better is required to move on to 36-226.

** A grade of C or better is required to move on to 36-401 .

3. Economics Electives 18 units

Choose two advanced electives. Advanced Elective courses are 73-xxx courses numbered 300 through 495, as well as courses designated by the Undergraduate Economics Program which are offered by other departments/programs.

4. Statistics Electives 18 units

Choose two 36-xxx courses at the 300 or 400 level.

Total number of units for the major	185 units
Total number of units for the degree	360 units

Sample Program

The following sample program illustrates one (of many) ways 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		Sophomore	
Fall	Spring	Fall	Spring
21-120 Differential and Integral Calculus	36-202 Statistical Methods	36-225 Introduction to Probability Theory	36-226 Introduction to Probability and Statistics II
36-201 Statistical Reasoning and Practice	73-150 Intermediate Microeconomics	73-200 Intermediate Macroeconomics	73-252 Advanced Microeconomic Theory
73-100 Principles of Economics	21-259 Calculus in Three Dimensions	21-122 Integration, Differential Equations and Approximation	73-253 Advanced Macroeconomic Theory
----- **	15-110 Principles of Computing	-----	21-241 Matrix Algebra
-----	-----	-----	-----

Junior*		Senior	
Fall	Spring	Fall	Spring
36-401 Modern Regression	36-402 Advanced Data Analysis	Statistics Elective	Economics Elective
73-261 Econometrics	Statistics Elective	-----	-----
73-270 Writing for Economists	Economics Elective	-----	-----
-----	-----	-----	-----
-----	-----	-----	-----

* A student could spend, for example, year 3 abroad and move year 3 courses to year 4.

**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.

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

BERNIE DEVLIN, Adjunct Associate Professor Ph.D., Pennsylvania State University; Carnegie Mellon, 1994.

WILLIAM F. EDDY, John C. Warner Professor of Statistics Ph.D., Yale University; Carnegie Mellon, 1976.

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, 1990.

ROBERT E. KASS, Professor of Statistics Ph.D., University of Chicago; Carnegie Mellon, 1981.

ANN LEE, Assistant 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.

ODED MEYER, Associate Teaching Professor Ph.D., University of Pittsburgh; Carnegie Mellon, 1999.

REBECCA NUGENT, Visiting Assistant Professor Ph.D., University of Washington; Carnegie Mellon, 2006.

ALESSANDRO RINALDO, Assistant Professor Ph.D., Carnegie Mellon; Carnegie Mellon, 2005.

KATHRYN ROEDER, Professor of Statistics Ph.D., Pennsylvania State University; Carnegie Mellon, 1994.

CHAD M. SCHAFER, Assistant 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.

HOWARD SELTMAN, Associate Research Professor Ph.D., Carnegie Mellon University Medical College of Pennsylvania - M.D.; Carnegie Mellon, 1999.

COSMA SHALIZI, Assistant Professor Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2005.

VALERIE VENTURA, Associate Research Professor Ph.D., University of Oxford; Carnegie Mellon, 1997.

ISABELLA VERDINELLI, Professor in Residence Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991.

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.

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.

Visiting Faculty

DREW THOMAS, Ph.D., Harvard; Carnegie Mellon, 2009.

MICHAEL FINEGOLD, Ph.D., University of Chicago; Carnegie Mellon, 2010.

STEVE HANNEKE, Ph.D., Carnegie Mellon University; Carnegie Mellon, 2009.

Mellon College of Science

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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 page 56

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 page 76

Science and Humanities Scholars Program (SHS)

Students in the Science and Humanities Scholars Program (SHS) are jointly admitted to MCS and the College of Humanities and Social Sciences (H&SS). 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 page 66

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 sections 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 page 56

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 Honors

Undergraduates in the Mellon College of Science will be awarded MCS Research Honors at the completion of their degree if they have met one of these requirements:

1. Successfully completed the Honors BS/MS program in the Department of Chemistry or Department of Mathematical Sciences.
OR
2. Successfully completed the departmental honors program in Biological Sciences or Chemistry.
OR
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 such as a peer reviewed publication, research thesis, or presentation at an external scientific meeting is required.

Final approval of nominations for MCS research 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 of Atmospheric Particle Study's goal is to be the world leader in science, engineering, and policy covering the full role of fine particulate matter in the atmosphere. Our goal in research is to advance the state of knowledge across this spectrum substantially, to provide both policy-relevant research, and to participate directly and actively in the evolution of environmental policy related to particulate matter.

The Center for Computational Finance's mission is to improve the interaction between academic research and the finance industry.

The Center for Macromolecular Engineering's goals are to enhance the benefits of polymer science to society by developing new methods to prepare advanced polymer materials, train and develop tomorrow's scientists, and transfer technology to industry.

The Center of Nano-enabled Device and Energy Technologies' mission is to work on real-world problems that can be solved potentially with appropriate nano-enabled technologies.

The Center for the Neural Basis of Cognition is a joint program between Carnegie Mellon University and the University of Pittsburgh. It synthesizes the disciplines of basic and clinical neuroscience, cognitive psychology, and computer science, combining neurobiological, behavioral, computational, and brain imaging methods.

The Center for Nonlinear Analysis was established in 1991. A special focus for applications emphasizes new and innovative methods to study contemporary issues in materials science. The center has created a vigorous environment for collaboration among mathematical and allied scientists.

The Center for Nucleic Acids Science and Technology is a community of Carnegie Mellon scientists and engineers unified by interests in the chemistry, biology, and physics of DNA, RNA, and PNA (peptide nucleic acid).

The Institute for Green Science has been established as a research, education, and development 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.

03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry I	10
15-110	Principles of Computing	10
	Or any other programming course which has been preapproved by the Dean.	
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
33-111	Physics I for Science Students	12
33-112	Physics II for Science Students	12

In the first year, students take two semesters of calculus, 21-120 Differential and Integral Calculus and 21-122 Integration, Differential Equations and Approximation. 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

21-120	Differential and Integral Calculus	10
xx-xxx	Science Core Course	9-12
xx-xxx	Science Core Course	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Optional First-Year Seminar or Discovery-Based Lab	3-6

Spring Semester 43-53 units

21-122	Integration, Differential Equations and Approximation	10
xx-xxx	Science Core Course	9-12
xx-xxx	Departmental Elective from Intended Major	9-10
xx-xxx	Humanities, Social Sciences, or Fine Arts Course	9
xx-xxx	Optional Free Elective Course or Discovery-Based Lab	6-9
xx-xxx	Optional First-Year Seminar	3

Notes

1. Departmental electives from the intended major are as follows:
Biological Sciences or Chemistry:
 09-106 Modern Chemistry II (10 units)
Mathematical Sciences
 21-127 Concepts of Mathematics (9 units)
Physics
 33-104 Experimental Physics (9 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 3 or 6 unit elective inquiry-based laboratory courses:

03-115	Phage Genomics Research	6
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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	4
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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 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

80-130 Introduction to Ethics 9
 80-150 Nature of Reason 9
 80-180 The Nature of Language 9
 80-208 Critical Thinking 9
 80-220 Philosophy of Science 9
 80-221 Philosophy of Social Science 9
 80-230 Ethical Theory 9
 80-241 Ethical Judgments in Professional Life 9
 80-242 Conflict and Dispute Resolution 9
 80-270 Philosophy of Mind 9
 80-312 Philosophy of Mathematics 9
 85-100 Introduction to Intelligence in Humans, Animals and Machines 9
 85-102 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

Category 2: Economic, Political and Social Institutions

70-332 Business, Society and Ethics 9
 73-100 Principles of Economics 9
 79-306 Delinquency, Crime and Juvenile Justice, 1967 to the Present 9
 79-319 Protest and Dissent in American History 9
 79-330 Medicine and Society 9
 79-335 Drug Use and Drug Policy 9
 79-341 The Cold War in Documents and Film 9
 79-350 Early Christianity 9
 79-374 American Environmental History: Critical Issues 9
 79-377 Food, Culture, and Power: A History of Eating 9
 79-392 History of Modern Warfare 9
 80-135 Introduction to Political Philosophy 9
 80-136 Social Structure, Public Policy & Ethics 9
 80-226 Revolutions in Science 9
 80-235 Political Philosophy 9
 80-245 Medical Ethics 9
 80-276 Philosophy of Religion 9
 80-341 Computers, Society and Ethics 9
 80-344 Management, Environment, and Ethics 9
 88-104 Decision Processes in American Political Institutions 9
 88-110 Experiments with Economic Principles 9
 88-205 Comparative Politics 9

Category 3: Cultural Analysis

57-173 Survey of Western Music History 9
 70-342 Managing Across Cultures 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
 79-202 Flesh and Spirit: Early Modern Europe, 1400-1800 9
 79-207 Development of European Culture 9
 79-240 The Development of American Culture 9
 79-241 African American History I -American History I 9
 79-242 African American History II -American History II 9
 79-255 Irish History 9
 79-261 Chinese Culture and Society 9
 79-265 Russian History: From the First to the Last Tsar 9
 79-276 Theory and Practice in the Anthropology of Globalization 9
 79-281 Introduction to Religion 9
 79-307 Religion and Politics in the Middle East 9
 79-310 Religions of China 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
 80-253 Continental Philosophy 9
 80-254 Analytic Philosophy 9
 80-255 Pragmatism 9
 80-261 Empiricism and Rationalism 9
 82-xxx Any Course Offered by Modern Languages 9

C. Elective Course Requirements (36 units)

Complete courses totaling 36 units from H&SS, CFA, or Business Administration. These can include language courses and music courses, for instance. In this category, you have the freedom to design how you want to structure your remaining general education requirements. For example you can use these electives to build a depth sequence of 2-4 courses in a particular area or you can take courses from different areas or some combination of each.

Check our web site for courses from H&SS, CFA and Business Administration that may not be used to satisfy these requirements, plus a list of courses in other colleges (including CIT and the Heinz College) that do satisfy these requirements. Click here for more information.

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. Undergraduate students will be considered for transfer after spring mid-semester grades for the first year have been posted.

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 returning student's form for Enrollment Services; and
- 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 2.00 or higher for all courses taken after the first year. A minimum of 360 units must be completed. This will include the MCS Science Core Courses, H&SS or CFA 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

The Minor in Health Care Policy and Management

Sponsored by:

H. John Heinz III College
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
Brenda Peyser, 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.

For more information, please visit page 66.

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 postgraduate 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 (focusing 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)

09-217	Organic Chemistry I	9
	or09-219 Modern Organic Chemistry (10 units)	
09-218	Organic Chemistry II	9
	or09-220 Modern Organic II (10 units)	
03-231 /232	Biochemistry I	9

Laboratory Requirement (12 units)

09-221	Laboratory I: Introduction to Chemical Analysis	12
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Statistics Requirement (9 units)

36-217	Probability Theory and Random Processes	9
36-225	Introduction to Probability Theory	9
36-247	Statistics for Lab Sciences	9

Additional Course Requirements:

Complete one course from each of the following groups (substitutions can be made with the approval of the Environmental Science Advisor).

Note: Courses taken in these categories cannot also be counted toward requirements for a primary major.

Science (Mechanism)

03-442	Molecular Biology	9
09-510	Introduction to Green Chemistry	9
09-520	Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods	9
06-630	Atmospheric Chemistry, Air Pollution and Global Change	12
xx-xxx	Course credit may be assigned for research, fieldwork, or coursework performed outside of CMU at the discretion of the minor advisor.	

Engineering (Process)

12-100	Introduction to Civil and Environmental Engineering	12
12-201	Geology	9
12-651	Air Quality Engineering	9
19-440	Combustion and Air Pollution Control	9

Policy

19-424	Energy and the Environment	9
19-448	Science, Technology & Ethics	9
73-358	Economics of the Environment and Natural Resources	9
79-289	Energy, Environment, Globalization in the Americas	9
79-372	Perspectives on the Urban Environment	9
79-375	China's Environmental Crisis	9
80-344	Management, Environment, and Ethics	9

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:

03-310	Introduction to Computational Biology	12
09-560	Molecular Modeling and Computational Chemistry	12
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
33-232	Mathematical Methods of Physics	9
33-456	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)

Department of Biological Sciences

Nathan N. Urban, Department Head
Maggie Braun, Assistant Department Head for Undergraduate Affairs
Undergraduate Office: Doherty Hall 1320

<http://www.cmu.edu/bio>

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 new 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:

Biological Sciences	Units
03-121 Modern Biology	9
03-231 Biochemistry I	9
03-240 Cell Biology	9
03-201 /202 Undergraduate Colloquium for Sophomores	2
03-330 Genetics	9
03-343 Experimental Techniques in Molecular Biology	12
03-344 Experimental Biochemistry	12
or03-345 Experimental Cell and Developmental Biology (12 units)	
03-411 Topics in Research	1
03-412 Topics in Research	1
03-XXX Biological Sciences Electives ⁽¹⁾	54
Total Biology units	118

1. Details on electives can be found in the "Biological Sciences Electives" section (see below).

Mathematics, Physics and Computer Science	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
33-111 Physics I for Science Students	12
33-112 Physics II for Science Students	12
15-110 Principles of Computing ⁽²⁾	10
99-10X Computing at Carnegie Mellon	3
Total Science units	57

2. 15-101 Exploring Programming with Alice or 15-102 Exploring Programming with Graphics can substitute for 15-110 towards the completion of the Programming course requirement.

Chemistry	Units
09-105 Introduction to Modern Chemistry I	10
09-106 Modern Chemistry II	10
09-217 Organic Chemistry I	9
or09-219 Modern Organic Chemistry (10 units)	
09-218 Organic Chemistry II	9
or09-220 Modern Organic II (10 units)	
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-214 Physical Chemistry	9
Total Chemistry units	71

Elective Units	Units
Free Electives	42
H&SS/CFA Electives	72
Total Elective units	114

Minimum number of units required for degree: 360

Biological Sciences Electives

The following specifications apply to Biological Sciences electives:

- At least 18 units must be at the 03-3XX 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.
- 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.

Departmental Electives Group

03-115 /116 Phage Genomics Research	12
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
03-310 Introduction to Computational Biology	12
03-311 Introduction to Computational Molecular Biology	6
03-312 Introduction to Computational Biological Modeling and Imaging	6
03-315 Magnetic Resonance Imaging in Neuroscience	9
03-325 Evolution	9
03-350 Developmental Biology	9
03-362 Cellular Neuroscience	9
03-363 Systems Neuroscience	9
03-380 Virology	9
03-390 Molecular and Cellular Immunology	9
03-391 Introduction to Microbiology	9
03-392 Microbiology Laboratory	6
03-439 Introduction to Biophysics	9
03-442 Molecular Biology	9
03-445 Undergraduate Research	Var.
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
03-710 Computational Biology	12
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
03-725 Evolution	12
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
15-211 Fundamental Data Structures and Algorithms	12
21-127 Concepts of Mathematics	9
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 complete 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 units)	

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:

03-740 Advanced Biochemistry	12
03-439 Introduction to Biophysics	9
21-259 Calculus in Three Dimensions	9
or 21-260 Differential Equations (9 units)	

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

One of the following courses:

03-362 Cellular Neuroscience	9
03-390 Molecular and Cellular Immunology	9

Computational Biology OptionRequired Biology Electives:

03-710	Computational Biology	12
15-211	Fundamental 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	Matrix Algebra	9

Recommended Biology Electives:

03-511	Computational Molecular Biology and Genomics	9
03-512	Computational Methods for Biological Modeling and Simulation	9
15-212	Principles of Programming	12
15-451	Algorithm Design and Analysis	12
09-560	Molecular Modeling and Computational Chemistry	12

Developmental Biology OptionRequired Biology Electives:

03-350	Developmental Biology	9
03-442	Molecular Biology	9
03-751	Advanced Developmental Biology	12

Recommended Biology Electives:

03-325	Evolution	9
03-741	Advanced Cell Biology	12

Genetics OptionRequired Biology Electives:

03-325	Evolution	9
03-442	Molecular Biology	9
03-730	Advanced Genetics (minimum grade of B in 03-330 required)	12

Recommended Biology Electives:

03-311	Introduction to Computational Molecular Biology	6
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Molecular Biology OptionRequired Biology Electives:

03-442	Molecular Biology	9
09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	9

Any one of the following:

03-325	Evolution	9
03-380	Virology	9
03-390	Molecular and Cellular Immunology	9
03-730	Advanced Genetics	12

Neuroscience OptionRequired Biology Electives:

03-362	Cellular Neuroscience	9
03-363	Systems Neuroscience	9

Any two of the following courses:

03-230	Intro to Mammalian Physiology	9
03-315	Magnetic Resonance Imaging in Neuroscience	9
03-350	Developmental Biology	9
03-534	Biological Imaging and Fluorescence Spectroscopy	9
03-761	Neural Plasticity	9
85-219	Biological Foundations of Behavior	9

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:

03-230	Intro to Mammalian Physiology	9
03-315	Magnetic Resonance Imaging in Neuroscience	9
03-350	Developmental Biology	9
03-534	Biological Imaging and Fluorescence Spectroscopy	9
15-485	Computational Perception	9
15-385	Computer Vision	9
15-490	Special Topic: Computational Neuroscience	9
85-211	Cognitive Psychology	9
85-213	Human Information Processing and Artificial Intelligence	9
85-219	Biological Foundations of Behavior	9

Mini courses of possible interest:

03-101	Biological Sciences First Year Seminars	3
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B.S. Computational Biology

The Bachelor of Science in Computational Biology is now listed in the Intercollege 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).

Professional Masters Degree in Computational Biology

Students who are interested in more advanced training in this emerging field may want to consider the Professional 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).

B.S. Biological Sciences and Psychology

This unified 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. 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.

Degree Requirements:

Biological Sciences	Units
03-121 Modern Biology	9
03-231 Biochemistry I	9
03-240 Cell Biology	9
03-201 /202 Undergraduate Colloquium for Sophomores	2
03-330 Genetics	9
03-343 Experimental Techniques in Molecular Biology	12
03-411 Topics in Research	1
03-412 Topics in Research	1
03-XXX General Biology Elective	9
03-3XX Advanced Biology Elective	9
03-3XX Advanced Biology Elective	9
Total Biology units	79

Mathematics, Statistics, Physics and Computer Science	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
36-247 Statistics for Lab Sciences	9
36-309 Experimental Design for Behavioral and Social Sciences	9
33-111 Physics I for Science Students	12
33-112 Physics II for Science Students	12
15-110 Principles of Computing ⁽³⁾	10
99-10X Computing at Carnegie Mellon	3
Total Science units	75

3. 15-101 Exploring Programming with Alice or 15-102 Exploring Programming with Graphics can substitute for 15-110 towards completion of the Programming course requirement.

Chemistry	Units
09-105 Introduction to Modern Chemistry I	10
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
Total Chemistry units	62

Psychology Courses	Units
85-102 Introduction to Psychology	9
85-219 Biological Foundations of Behavior	9
85-2XX Survey Psychology Courses ⁽⁴⁾	18
85-310 Research Methods in Cognitive Psychology or 85-340 Research Methods in Social Psychology (9 units) or 85-320 Research Methods in Developmental Psychology (9 units)	9
85-3XX Advanced Psychology Electives	18
Total Psychology units	63

4. Excluding 85-261 Abnormal Psychology

Additional Advanced Elective

(Choose one of the following courses) 9 units

85-3XX Advanced Psychology Elective	9
or	
03-3XX Advanced Biology Elective	9

Additional Laboratory or Research Methods

(Choose one of the following courses) 9-12 units

03-344 Experimental Biochemistry	12
03-345 Experimental Cell and Developmental Biology	12
85-310 Research Methods in Cognitive Psychology	9
85-320 Research Methods in Developmental Psychology	9
85-340 Research Methods in Social Psychology	9

Elective Units	Units
Free Electives	33-36
H&SS/CFA Electives	36
Total Elective units	69-72

Minimum number of units required for degree: 360

B.A. Biological Sciences

The Department of Biological Sciences offers a Bachelor of Arts (B.A.) degree that is intended for students who wish to combine their interest in science with their interest(s) in other discipline(s) across campus. The requirements for the B.A. degree are distributed as follows:

Degree Requirements:

Biological Sciences	Units
03-121 Modern Biology	9
03-231 Biochemistry I	9
03-240 Cell Biology	9
03-201 /202 Undergraduate Colloquium for Sophomores	2
03-330 Genetics	9
03-343 Experimental Techniques in Molecular Biology or 03-124 Modern Biology Laboratory (9 units)	12
03-411 Topics in Research	1
03-412 Topics in Research	1
03-XXX General Biology Electives ⁽⁵⁾	18
03-3XX Advanced Biology Electives ⁽⁶⁾	18
Total Biology units	88

5,6. Please see description and requirements for electives under the B.S. in Biological Sciences section of this catalog.

Chemistry	Units
09-105 Introduction to Modern Chemistry I	10
09-106 Modern Chemistry II	10
09-217 Organic Chemistry I or 09-219 Modern Organic Chemistry (10 units)	9
09-218 Organic Chemistry II or 09-220 Modern Organic II (10 units)	9
09-221 Laboratory I: Introduction to Chemical Analysis	12
Total Chemistry units	50

Mathematics, Physics, and Computer Science	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
33-111 Physics I for Science Students	12
33-112 Physics II for Science Students	12
15-110 Principles of Computing ⁽⁷⁾	10
99-10X Computing at Carnegie Mellon	3
Total Science units	57

7. 15-101 Exploring Programming with Alice or 15-102 Exploring Programming with Graphics can substitute for 15-110 towards completion of the Programming course requirement.

Elective courses	Units
H&SS/CFA Electives	72
Free Electives	99-102
Total Elective units	171-174

Minimum number of units required for degree: 360

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	Units
Prerequisites:	
09-105 Introduction to Modern Chemistry I	10
09-217 Organic Chemistry I	9
Required courses:	
03-121 Modern Biology	9
03-231 /232 Biochemistry I	9
03-240 Cell Biology	9
03-330 Genetics	9
03-XXX General Biology Elective	9
03-3XX Advanced Biology Elective	9
Minimum number of units required for the minor:	73

Faculty

ERIC T. AHRENS, Associate 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.

PETER B. BERGET, Associate Professor Ph.D., University of Minnesota; Carnegie Mellon, 1986.

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AMY L. BURKERT, Teaching Professor and Vice Provost for Education Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997.

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ERIC W. GROTZINGER, Teaching Professor and Associate Dean of Undergraduate Affairs for MCS Ph.D., University of Pittsburgh; Carnegie Mellon, 1979.

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JONATHAN W. JARVIK, Associate Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978.

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GORDON S. RULE, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996.

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KARL KANDLER, Associate Professor of Otolaryngology and Neurobiology at the University of Pittsburgh Ph.D., University of Tübingen, Germany; .

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Emeriti Faculty

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

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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 an area of science involved with the study of the properties and reactions of substances ranging from living cells to subatomic particles. It is at the center of many sciences, providing the fundamental knowledge and tools needed to address many of society's needs and to explore the unknown. Fields as diverse as genetic engineering and nanotechnology look to chemistry when they look to the future, for that is where the ultimate in understanding - the molecular level - resides.

The chemistry profession is extraordinarily diverse, with career opportunities available in the chemical, petroleum, plastics, metals, and pharmaceutical industries. Chemistry plays an increasingly important role in the rapidly expanding biomedical and biotechnology industries. In addition to careers in industry and academia, many chemists find challenging careers in the public sector in the laboratories of the National Institutes of Health, the Department of Agriculture, the Environmental Protection Agency, the National Institute of Standards and Technology, and the Department of Energy as well as in consulting.

Chemistry is a particularly suitable major for pre-medical and other pre-health profession students. Medical schools look favorably on the rigorous reasoning skills chemists develop, as evidenced by an excellent record for student admission to advanced education in these areas. An increasing number of our graduates are seeking careers in dentistry, pharmacy or pharmacology. The Health Professions Program advises all Carnegie Mellon students considering careers in health fields. (See Health Professions Program description in this catalog for more information.) Chemistry is particularly attractive to pre-law majors anticipating a career in a legal department in a chemical industry, in patent, intellectual property or environmental law. Students interested in industrial careers often combine their chemistry program with undergraduate courses in business administration or go on to study for an M.B.A.

The Department offers two degrees: the B.S. and the B.A. One third of the courses for the B.A. degree are free electives that may be taken in any of the departments of the University and therefore offer a high degree of flexibility. For the B.S. degree, electives normally are technical courses in chemistry or related fields of sciences, such as biology, physics, mathematics, or computer science, although they can be in other non-technical areas as well. It is possible to have all of the technical requirements completed after the junior year, allowing students the flexibility to combine electives in the senior year into a focused program of specialization. One of these programs is the B.S. in chemistry with the computational chemistry track. The track is an intense concentration in coursework related to scientific computing. 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 country 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 Departmental Honors requires the completion of at least one graduate level course, 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 90 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 in Europe, Asia, New Zealand, and Australia during both the academic year and the summer. 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. Participation in undergraduate research is encouraged and qualified students may begin projects as early as their second year. 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.

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 may find the Bachelor of Arts degree a more suitable alternative.

Curriculum - B.S. 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 (15-101 and 15-102 are also acceptable in order to fulfill the programming requirement). 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

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
99-101 Computing @ Carnegie Mellon	3
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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.

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 1	9
15-110 Principles of Computing	10
15-101 Programming with Alice or 15-102 Programming with Graphics can substitute for 15-110 in fulfilling the MCS Programming Requirement	
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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
09-231 Mathematical Methods for Chemists	9
03-121 Modern Biology	9
(core elective or free elective)	
xx-xxx H&SS Distribution Course 2	9
	<hr/> 50

Spring	Units
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-204 Professional Communication Skills in Chemistry (It is recommended that this course be completed prior to taking 09-321, Lab III.)	3
09-220 Modern Organic II	10
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-348 Inorganic Chemistry	10
xx-xxx H&SS Distribution Course 3	9
	<hr/> 45

Junior Year

Fall	Units
09-301 Undergraduate Seminar III	1
09-321 Laboratory III: Molecular Design and Synthesis	12
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-331 Modern Analytical Instrumentation	9
xx-xxx H&SS/CFA Elective 1 (of 4)	9
	<hr/> 40

Spring	Units
09-302 Undergraduate Seminar IV	1
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-xxx Chemical Elective (see Notes on Electives)	9
xx-xxx H&SS/CFA Elective 2 (of 4)	9
	<hr/> 40

Senior Year

Fall	Units
09-401 Undergraduate Seminar V	1
09-xxx Chemical Elective (see notes on electives)	9
xx-xxx Free Electives	27
xx-xxx H&SS/CFA Elective 3 (of 4)	9
	<hr/> 46

Spring	Units
09-402 Undergraduate Seminar VI	3
xx-xxx Electives	36
xx-xxx H&SS/CFA Elective 4 (of 4)	9
	<hr/> 48

Certain non-technical courses from Business Administration, Heinz College, and EPP also may be used. 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, marketing, 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. Degree and Requirements for An Additional Major in Chemistry

Minimum Total Chemistry Units 163; See distribution below

Required Chemistry Courses* Units	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 II	10
09-231 Mathematical Methods for Chemists	9
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
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
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-xxx Chemistry Seminars	8
09-xxx Chemistry Electives	18

* 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 .

21-259 Calculus in Three Dimensions, and an additional Mathematics/Statistics Elective (see Notes on Electives below) can be taken to fulfill the requirement for 09-231.

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.

Other Requirements	Units
Biology	9
Computer Science	10
Mathematics	20
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Free Electives	61
Computing @ Carnegie Mellon	3
Minimum number of units required for the degree:	360

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

Mathematics/Statistics Elective

The B.S. degree in Chemistry requires 09-231 Mathematical Methods for Chemists as the advanced math requirement. In order to provide some flexibility, a student may take 21-259 Calculus in Three Dimensions and one 9-unit advanced mathematics or statistics elective course to fulfill this requirement. Recommended courses include (but are not necessarily limited to): 21-260 Differential Equations, 21-127 Concepts of Mathematics, or 36-247 Statistics for Lab Sciences. Less mathematically rigorous courses in statistics such as 36-201 Statistical Reasoning and Practice and 36-202 Statistical Methods cannot be used towards fulfillment of this requirement. You should verify your selection with your advisor before completing your mathematics elective.

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 09-3xx or higher, undergraduate or graduate level, for which the student has the necessary prerequisites, or by 03-231/03-232 Biochemistry. Independent Study in Chemistry 09-435 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.

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	Units
03-231 /232 Biochemistry I	9
03-330 Genetics	9
03-344 Experimental Biochemistry	12
xx-xxx Elective in Biochemistry	
Elective may be 03-439 Introduction to Biophysics, 03-740 Advanced Biochemistry, 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates, or 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	

POLYMER SCIENCE OPTION	Units
06-466 Experimental Polymer Science	9
09-502 Organic Chemistry of Polymers	9
09-509 Physical Chemistry of Macromolecules	9
09-xxx Elective in Polymer Science	9
Elective may be 09-445, Undergraduate Research (polymer project) or an upper level course in polymer science.	

COLLOIDS, POLYMERS and SURFACES OPTION (offered jointly with the Department of Chemical Engineering)	Units
06-426 Experimental Colloid Surface Science	9
06-466 Experimental Polymer Science	9
09-509 Physical Chemistry of Macromolecules	9
06-607 Physical Chemistry of Colloids and Surfaces	9

MATERIALS CHEMISTRY	Units
27-100 Engineering the Materials of the Future	12
27-201 Structure of Materials	9
Two Elective Courses (from list below)	
27-202 Defects in Materials	9
06-426 Experimental Colloid Surface Science	9
09-445 Undergraduate Research	9
09-502 Organic Chemistry of Polymers	9
42-511 Biomaterials	9
27-xxx Approved MSE Course	9

ENVIRONMENTAL CHEMISTRY OPTION	Units
09-510 Introduction to Green Chemistry	9
Three Elective Courses (from the list below or other courses approved by Director of Undergraduate Studies; only one 19-xxx course can be applied to this option)	
19-424 Energy and the Environment	9
19-440 Combustion and Air Pollution Control	9
09-520 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods	9
19-614 Environmental Life Cycle Assessment and Green Design	6
06-630 Atmospheric Chemistry, Air Pollution and Global Change	12
12-651 Air Quality Engineering	9
12-657 Water Resources Engineering	9

MANAGEMENT OPTION	Units
70-101 Introduction to Business Management	9
73-100 Principles of Economics	9
70-122 Introduction to Accounting	9
70-364 Business Law	9
or 70-365 International Trade Law	

COMPUTATIONAL CHEMISTRY OPTION		Units
15-110	Principles of Computing	10
15-121	Introduction to Data Structures	10
21-369	Numerical Methods	9
09-560	Molecular Modeling and Computational Chemistry	12
xx-xxx	One upper level Computational Elective Course	9
15-211	Fundamental Data Structures and Algorithms	12
33-241	Introduction to Computational Physics	9
03-310	Introduction to Computational Biology	12
03-511	Computational Molecular Biology and Genomics	9
03-512	Computational Methods for Biological Modeling and Simulation	9
09-701	Quantum Chemistry I	12

The Chemistry/Computational Chemistry Track (described later) requires the completion of two upper level Computer Science Courses 15-211 and 15-251. In the option 15-121 and 21-369 are taken in place of these two courses. Since both 15-211 and 15-251 are prerequisites for higher level computer science courses, students in the Computational Chemistry Option should note that they are essentially blocked from taking additional courses in the Computer Science Department as senior computing electives. Students who complete 15-211 but not 15-251 may count 15-211 towards the Computational Chemistry Option as the required elective. Students pursuing the Computational Chemistry Option must complete course 15-110 as part of their MCS computing requirement.

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 09-455 Honors Thesis (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 for candidacy 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. 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. In April or early May of the senior year, 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. Students completing the B.S. with Departmental Honors in Chemistry will receive MCS Research Honors as well.

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. 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 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.

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 is 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 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 Committee. 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 withstand the scrutiny of the Honors 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.

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 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	Units
03-121 Modern Biology	9
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
99-101 Computing @ Carnegie Mellon	3
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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.

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 1	9
15-110 Principles of Computing	10
15-101 Programming with Alice and 15-102 Programming with Graphics are suitable substitutes for 15-110 towards the completion of the MCS Programming requirement.	
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Sophomore Year

Fall	Units
09-231 Mathematical Methods for Chemists	9
09-219 Modern Organic Chemistry	10
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-201 Undergraduate Seminar I	1
xx-xxx H&SS Distribution Course 2	9
	<hr/> 41

Spring	Units
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-204 Professional Communication Skills in Chemistry	3
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-220 Modern Organic II	10
09-348 Inorganic Chemistry	10
xx-xxx H&SS Distribution Course 3	9
	<hr/> 45

Summer
10 weeks Honors Research recommended

Junior Year

Fall	Units
09-301 Undergraduate Seminar III	1
09-321 Laboratory III: Molecular Design and Synthesis	12
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-331 Modern Analytical Instrumentation	9
09-445 Undergraduate Research	10
xx-xxx H&SS/CFA Elective 1 (of 4)	9
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Spring	Units
09-302 Undergraduate Seminar IV	1
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-445 Undergraduate Research	10
09-xxx Graduate Chemistry Course (see notes on Honors B.S./M.S. electives)	12
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
xx-xxx H&SS/CFA Elective 2 (of 4)	9
	<hr/> 53

Summer
10 weeks Honors Research recommended

Senior Year

Fall	Units
09-401 Undergraduate Seminar V	1
09-445 Undergraduate Research	10
09-xxx Graduate Chemistry Course	12
09-xxx Graduate Chemistry Course	12
xx-xxx H&SS/CFA Elective 3 (of 4)	9
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Spring	Units
09-402 Undergraduate Seminar VI	3
09-455 Honors Thesis	15
09-xxx Graduate Chemistry Course	12
09-xxx Graduate Chemistry Course	12
xxx-xxx H&SS/CFA Elective 4 (of 4)	9
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Certain non-technical courses from Business Administration, Heinz College, and EPP also may be used. 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, marketing, 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)

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 II	10
09-231 Mathematical Methods for Chemists	9
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
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
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-xxx Chemistry Seminars	8
Undergraduate Research (2 summers also recommended)	30
Graduate chemistry courses (see notes on B.S./M.S. electives)	60
09-455 Honors Thesis	15

09-107 Honors Chemistry: Fundamentals Concepts and Applications, may be taken instead of 09-105 .

21-259 Calculus in Three Dimensions, and an additional Mathematics/Statistics Elective (see Notes on Electives in the B.S. in Chemistry section) can be taken to fulfill the requirement for 09-231 .

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.

Other Requirements	Units
Biology	9
Computer Science	10
Mathematics	20
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Computing @ Carnegie Mellon	3
Minimum number of units required for degrees:	388

B.S. in Chemistry/Computational Chemistry Track

The use of computers is ubiquitous in chemistry. Theoretical chemists run large number-crunching programs on supercomputers to understand and predict molecular structures, properties, and reactivity. Experimental physical chemists use computers to develop models to their data. Organic and inorganic chemists use computers to plan complex sequences of reactions and predict 3D structures and properties of molecules. Analytical chemists use microprocessors to control instruments and robots to perform repetitive processes.

Computer science will play a growing role in chemistry in the future, but very few people without a Ph.D. degree have the background in both fields that is necessary to make an impact. The B.S. in Chemistry/Computational Chemistry Track degree is a response to society's need for bachelor's degree scientists who can apply computational sophistication to the practical problems of science. It is simultaneously a response to the large number of students who want not merely to learn computer science, but to apply that expertise in a subject area that gives them an edge in the job market.

As the student builds expertise in chemistry by taking the full B.S. curriculum, elective courses are devoted to mathematics and computer science. This culminates with 09-560 Molecular Modeling and Computational Chemistry, which affords an overview of the areas of overlap of computer science with chemistry.

The degree designation on the transcript of students who complete the requirements for this program is: B.S. in Chemistry/Computational Chemistry Track. The track is not noted on the diploma.

Curriculum - B.S. in Chemistry/Computational Chemistry Track

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
99-101 Computing @ Carnegie Mellon	3
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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 1	9
15-110 Principles of Computing	10

15-101 Programming with Alice and 15-102 Programming with Graphics can substitute for 15-100 towards the completion of the MCS Programming requirement.

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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
21-127 Concepts of Mathematics	9
15-121 Introduction to Data Structures	10
xx-xxx H&SS Distribution Course 2	9
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Spring	Units
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-204 Professional Communication Skills in Chemistry	3
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-220 Modern Organic II	10
21-259 Calculus in Three Dimensions	9
15-211 Fundamental Data Structures and Algorithms	12
xx-xxx H&SS Distribution Course 3	9
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09-231 Mathematical Methods for Chemists, can be taken in lieu of 21-259. Note that 09-231 is offered only in the fall.

Junior Year

Fall	Units
09-301 Undergraduate Seminar III	1
09-321 Laboratory III: Molecular Design and Synthesis	12
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-331 Modern Analytical Instrumentation	9
15-251 Great Theoretical Ideas in Computer Science	12
xx-xxx H&SS/CFA Elective 1 (of 4)	9
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Spring	Units
09-302 Undergraduate Seminar IV	1
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
xx-xxx Computing Elective	9
03-121 Modern Biology	9
xx-xxx H&SS/CFA Elective 2 (of 4)	9
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Note that for this track 09-301 and 09-302 are not formally required, however you are encouraged to attend. These two courses are required for all other programs in chemistry.

Senior Year

Fall	Units
09-401 Undergraduate Seminar V	1
09-560 Molecular Modeling and Computational Chemistry	12
09-xxx Chemistry Elective	9
xx-xxx Free Elective	9
xx-xxx H&SS/CFA Elective 3 (of 4)	9
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09-560 Computational Chemistry may only be offered biannually and may move between the spring and fall semesters. You need to consult with your advisor as to the best time to schedule this course.

	Units
Spring	
09-402 Undergraduate Seminar VI	3
09-348 Inorganic Chemistry	10
xx-xxx Computing Elective	9
xx-xxx Free Elective	9
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. 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, marketing, 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.

Each student in the Computational Chemistry Track is required to complete two upper level mathematics and/or computer science electives. These may be chosen from the following list of courses. Others may be used with departmental approval.

Upper level Computing Courses Units

15-212 Principles of Programming	12
15-411 Compiler Design	12
15-312 Foundations of Programming Languages	12
15-413 Software Engineering Practicum	12
15-384 Robotic Manipulation	12
15-381 Artificial Intelligence: Representation and Problem Solving	9
Representation and Problem Solving	
15-385 Computer Vision	9
15-412 Operating System Practicum	Var.
15-xxx Approved Elective	9
15-462 Computer Graphics	12

Upper Level Mathematics Courses

21-369 Numerical Methods	9
21-228 Discrete Mathematics	9
21-301 Combinatorics (note 21-228 prerequisite)	9
21-xxx Approved Elective	9

Distribution of Units for the B.S. in Chemistry/Computational Chemistry Track

Minimum Total Chemistry Units 155; 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 II	10
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
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
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-560 Molecular Modeling and Computational Chemistry	12
09-xxx Chemistry Seminars	6
09-xxx Chemistry Elective	9

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 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.

Other Requirements	Units
Biology	9
Computer Science	43
Mathematics	38
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Computing or Math Electives	18
Computing @ Carnegie Mellon	3
Minimum number of units for the degree:	362

The above B.S. curriculum recommends an average course load of 37-55 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.

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 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
99-101 Computing @ Carnegie Mellon	3
	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.

	Units
Spring	
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 1	9
15-110 Principles of Computing	10
15-101 Programming with Alice or 15-102 Programming with Graphics can substitute for 15-110 in order to complete the MCS Programming Requirement	
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Sophomore Year

	Units
Fall	
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

	Units
Spring	
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-204 Professional Communication Skills in Chemistry	3
09-220 Modern Organic 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

	Units
Fall	
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

	Units
Spring	
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

	Units
Fall	
09-401 Undergraduate Seminar V	1
xx-xxx Free Electives	36
xx-xxx H&SS/CFA Elective 3 (of 4)	9
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	Units
Spring	
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. 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, marketing, 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 II	10
09-214 Physical Chemistry	9
or09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry (9 units)	
or09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry (9 units)	
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

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.

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 in 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 the added designation ...with 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 1317 or from the MCS undergraduate web page. It should be completed and submitted to the Director of Undergraduate Studies no later than midsemester 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.

A. Four Required Core Courses

09-106	Modern Chemistry II	10
09-221	Laboratory I: Introduction to Chemical Analysis	12
09-217	Organic Chemistry I	9
Choice of one of the following courses:		
09-344	Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-345	Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-347	Advanced Physical Chemistry	12
09-348	Inorganic Chemistry	10

Courses in this group that are not used to satisfy Part A core courses (section 4) may be used to satisfy elective course requirements in part B below, if they are not required by the student's primary department. However the only combination of physical chemistry courses (09-344, 09-345, 09-347 and 09-214) that is allowed is 09-344 and 09-345.

Enrollment in 09-347 is only open to students majoring in chemical engineering.

09-219 Modern Organic Chemistry may be taken in lieu of 09-217.

B. Two Elective Courses from the following list.

09-344	Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
or 09-214 Physical Chemistry (9 units)		
09-345	Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-348	Inorganic Chemistry	10
09-222	Laboratory II: Organic Synthesis and Analysis	12
09-218	Organic Chemistry II	9
03-231 /232	Biochemistry I	9
09-xxx	Approved Upper Level Chemistry Course	

Courses in this section (part B above) can not be counted toward the minor if they are required in any way by the student's primary department or towards an additional major or minor other than as a free elective. For example, students majoring in Biological Sciences can not double count 09-214, 03-231 (or 03-232), 09-222, or 09-218 toward the elective courses for the minor in chemistry. Chemical engineering majors can not count 03-231 (or 03-232) or a chemistry course that is used to satisfy that department's required chemistry or

advanced chem/biochem elective. Also, chemical engineering majors can not use 09-344, 09-345 or 09-214 due to the similarity of these courses to courses required by the chemical engineering department.

09-231, Mathematical Methods for Chemists, does not count towards the minor in chemistry. The undergraduate research course, 09-445, and 09-435, Independent Study in Chemistry, cannot be used for the minor.

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 Heinz College; 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.

Faculty

CATALINA ACHIM, Associate Professor of Chemistry Ph.D., Carnegie Mellon; Carnegie Mellon, 2001.

BRUCE A. ARMITAGE, Professor of Chemistry, Co-Director Center 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; 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 Research Professor, Program Manager, Technology Center for Networks and Pathways Ph.D., University of California, Berkeley; Carnegie Mellon, 2006.

TERRENCE J. COLLINS, Teresa Heinz Professor in Green Chemistry, Director, Institute for Green Oxidation Chemistry Ph.D., University Auckland, (New Zealand); Carnegie Mellon, 1987.

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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, Associate Research Professor and Director, NMR Facility Ph.D., Córdoba National University Córdoba, 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, Assistant Professor of Chemistry Ph.D., Northwestern University; Carnegie Mellon, 2006.

PAUL J. KAROL, Professor of Chemistry Ph.D., Columbia University; Carnegie Mellon, 1969.

HYUNG J. KIM, Professor of Chemistry and Head, Department of Chemistry Ph.D., State University of New York at Stony Brook; Carnegie Mellon, 1992.

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MAUMITA MANDAL, Assistant Professor of Chemistry Ph.D., Center for Cellular and Molecular Biology, Hyderabad, India; Carnegie Mellon, 2008.

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GARY D. PATTERSON, Professor of Chemistry Ph.D., Stanford University; Carnegie Mellon, 1984.

LINDA A. PETEANU, Associate Professor of Chemistry Ph.D., University of Chicago; Carnegie Mellon, 1992.

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LEONARD VUOCOLO, 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, Assistant Professor of Chemistry and Biomedical Engineering Ph.D., University of California, Berkeley; Carnegie Mellon, 2004.

PAUL M. WHITMORE, Research Professor and Director, Art Conservation Research Center Ph.D, University of California, Berkeley; Carnegie Mellon, 1988.

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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, 1958.

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.

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

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ANDREW GELLMAN, Thomas Lord Professor of Chemical Engineering and Head, Department of Chemical Engineering and Professor of 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 Chemistry Ph.D., University of Delaware; Carnegie Mellon, 1997.

Department of Mathematical Sciences

Roy A. Nicolaides, Head
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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 is consistently ranked among the top 15 departments of Applied Mathematics and Mathematical Sciences. We also note that our Logic group was ranked number 3 nationally. These research strengths are reflected in the variety of options that the Department provides for its undergraduate majors.

The Department offers a B.S. in Mathematical Sciences degree with concentrations in Mathematics, Operations Research, Statistics, Discrete Mathematics and Logic, and Computational and Applied Mathematics.

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 Concentration prepares students to enter an area 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 is designed to provide the necessary mathematical background for students who want to participate in the modern developments flowing from the computer. This concentration includes a strong component of computer science.

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 program. 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.

Analysis

For selected Freshmen entering the University, we offer 21-131/21-132 Analysis I/II, a more rigorous version of the first two semesters of calculus. Typically, a student choosing the Analysis Option has mastered the operational aspects of calculus and now seeks a deeper conceptual understanding.

Mathematical Studies

Following the Analysis sequence, we offer 21-235/21-236 Mathematical Studies I/II. This pair of intensive courses is team taught with a typical enrollment of about 15 students, allowing for close contact with faculty. Mathematical Studies provides an excellent preparation for graduate study, with many of the participants taking graduate courses as early as their Junior year. 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 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 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 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 is a flexible program which allows students to develop depth in both fields of study.

Finally, a joint program with the Heinz College and the Tepper School of Business leads to the degree Bachelor of Science in Computational Finance.

These programs are described in the catalog section on interdisciplinary programs.

Curricula

For each concentration, we provide a list of the requirements and a suggested schedule that takes prerequisites into account. A Mathematical Science, 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 beyond the calculus sequence, 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.

The first year of calculus is offered in a flexible format to allow placement of entering students appropriate for their background. In addition to the standard sequence 21-120 followed by 21-122, 21-121 allows students to start half-way through 21-120 and 21-123 allows students to start half-way through 21-122.

Mathematical Science majors are required to complete an introductory computer science course, either 15-110 or 15-121. Students who plan to take further computer science courses must complete 15-121.

An H&SS Elective refers to a course in the Humanities and Social Science 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.

In addition to the courses in the suggested schedules below, a student majoring in mathematical sciences also takes the one unit course 21-201 Undergrad 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

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-127 Concepts of Mathematics	9
21-201 Undergrad Colloquium	1
21-228 Discrete Mathematics	9
or21-301 Combinatorics (9 units)	
or21-484 Graph Theory (9 units)	
21-341 Linear Algebra	9
21-259 Calculus in Three Dimensions	9
21-260 Differential Equations	9
21-355 Principles of Real Analysis I	9
21-356 Principles of Real Analysis II	9
21-373 Algebraic Structures	9
	93

five Mathematical Sciences electives

Other courses

	Units
15-110 Principles of Computing	10
36-225 Introduction to Probability Theory	9
or21-325 Probability (9 units)	
	19

three Mathematical Sciences, Statistics, or Computer Science electives

MCS humanities, social science, and science core (114 units)

seven free electives

Suggested Schedule

Freshman Year

Fall	Units
21-120 Differential and Integral Calculus	10
33-111 Physics I for Science Students	12
15-110 Principles of Computing	10
03-121 Modern Biology	9
76-101 Interpretation and Argument	9
99-101 Computing @ Carnegie Mellon	3
	53

Spring	Units
21-122 Integration, Differential Equations and Approximation	10
21-127 Concepts of Mathematics	9
33-112 Physics II for Science Students	12
09-105 Introduction to Modern Chemistry I	10
xx-xxx H&SS Elective	9
	50

Sophomore Year

Fall	Units
21-228 Discrete Mathematics	9
or21-301 Combinatorics (9 units)	
or21-484 Graph Theory (9 units)	
21-341 Linear Algebra	9
21-259 Calculus in Three Dimensions	9
21-201 Undergrad Colloquium	1
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	46

Spring	Units
21-260 Differential Equations	9
21-201 Undergrad Colloquium	1
xx-xxx Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	37

Junior Year

Fall	Units
21-355 Principles of Real Analysis I	9
36-225 Introduction to Probability Theory	9
or21-325 Probability (9 units)	
xx-xxx Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	45

Spring	Units
21-356 Principles of Real Analysis II	9
21-373 Algebraic Structures	9
21-xxx Mathematical Sciences Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	45

Senior Year

Fall	Units
21-xxx Mathematical Sciences Elective	9
21-xxx Mathematical Sciences Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
xx-xxx Elective	9
	45

Spring	Units
21-xxx Mathematical Sciences Elective	9
21-xxx Mathematical Sciences Elective	9
xx-xxx Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	45

Minimum number of units for the degree:

360

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:

21-301	Combinatorics	9
21-342	Linear Algebra II	9
21-371	Functions of a Complex Variable	9
21-372	Partial Differential Equations	9
21-374	Field Theory	9
21-465	Topology and Geometry	9
21-470	Selected Topics in Analysis	9
21-476	Ordinary Differential Equations	9
21-484	Graph Theory	9
21-600	Mathematical Logic I	12
21-602	Introduction to Set Theory I	12
21-620	Real Analysis	6
21-621	Introduction to Lebesgue Integration	6
21-651	General Topology	12
21-660	Introduction to Numerical Analysis I	12

Note that courses 21-600 and above carry graduate credit. 600 level courses are designed as transitional courses to graduate study. A student preparing for graduate study should also consider undertaking an independent work. The Department offers 21-499 Undergraduate Research Topic and 21-599 Undergraduate Reading and Research for this purpose.

Operations Research 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 Mathematical Sciences 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.

The requirements for the concentration in Operations Research are:

Mathematical Sciences

		Units
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-201	Undergrad Colloquium	1
21-228	Discrete Mathematics	9
	or21-301 Combinatorics (9 units)	
	or21-484 Graph Theory (9 units)	
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-292	Operations Research I	9
21-369	Numerical Methods	9
21-393	Operations Research II	9
		93

Statistics

		Units
36-225	Introduction to Probability Theory	9
	or21-325 Probability (9 units)	
36-226	Introduction to Probability and Statistics II	9
36-401	Modern Regression	9
36-402	Advanced Data Analysis	9
36-410	Introduction to Probability Modeling	9
		45

Depth Electives

The detailed curriculum below includes five depth electives. These are to be chosen from among the following. 21-355 is particularly recommended for a student planning to pursue graduate work.

15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
21-270	Introduction to Mathematical Finance	9
21-355	Principles of Real Analysis I	9
21-365	Projects in Applied Mathematics	9
21-366	Topics in Applied Mathematics	9
21-370	Discrete Time Finance	9
21-373	Algebraic Structures	9
21-420	Continuous-Time Finance	9
21-484	Graph Theory	9
36-461	Topics in Statistics	9
36-462	Topics in Statistics	9
36-463	Topics in Statistics	9
36-464	Applied Multivariate Methods	9
70-371	Production/Operations Management	9
70-460	Mathematical Models for Consulting	9
70-471	Logistics and Supply Chain Management	9

Other Courses

		Units
15-110	Principles of Computing	10
70-122	Introduction to Accounting	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
73-200	Intermediate Macroeconomics	9
		46

MCS humanities, social science, and science core (120 units, including 73-100, 73-150 and 73-200)

Five free electives

Suggested Schedule

Freshman Year

		Units
Fall		
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
15-110	Principles of Computing	10
03-121	Modern Biology	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		53

		Units
Spring		
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics II for Science Students	12
09-105	Introduction to Modern Chemistry I	10
xx-xxx	H&SS Elective	9
		50

Sophomore Year

		Units
Fall		
21-228	Discrete Mathematics	9
	or21-301 Combinatorics (9 units)	
	or21-484 Graph Theory (9 units)	
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergrad Colloquium	1
73-100	Principles of Economics	9
		37

	Units
Spring	
21-260 Differential Equations	9
21-292 Operations Research I	9
21-201 Undergrad Colloquium	1
70-122 Introduction to Accounting	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	46

Junior Year

	Units
Fall	
21-369 Numerical Methods	9
xx-xxx Depth Elective	9
36-225 Introduction to Probability Theory	9
or 21-325 Probability (9 units)	
73-150 Intermediate Microeconomics	9
xx-xxx Elective	9
	45

	Units
Spring	
xx-xxx Depth Elective	9
36-226 Introduction to Probability and Statistics II	9
36-410 Introduction to Probability Modeling	9
xx-xxx H&SS Elective	9
73-200 Intermediate Macroeconomics	9
	45

Senior Year

	Units
Fall	
21-393 Operations Research II	9
xx-xxx Depth Elective	9
36-401 Modern Regression	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	45

	Units
Spring	
36-402 Advanced Data Analysis	9
xx-xxx Depth Elective	9
xx-xxx Depth Elective	9
xx-xxx H&SS Elective	9
xx-xxx Elective	9
	45

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 /36-226 Introduction to Probability and Statistics I/II 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

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-127 Concepts of Mathematics	9
21-201 Undergrad Colloquium	1
21-228 Discrete Mathematics	9
or 21-301 Combinatorics (9 units)	
or 21-484 Graph Theory (9 units)	
21-241 Matrix Algebra	9
21-259 Calculus in Three Dimensions	9
21-260 Differential Equations	9
21-292 Operations Research I	9
21-369 Numerical Methods	9
21-393 Operations Research II	9
	93

Statistics

	Units
36-225 Introduction to Probability Theory	9
or 21-325 Probability (9 units)	
36-226 Introduction to Probability and Statistics II	9
36-401 Modern Regression	9
36-402 Advanced Data Analysis	9
36-410 Introduction to Probability Modeling	9
	45

Depth Electives

The detailed curriculum below includes six depth electives. These are to be chosen from among the following including at least one statistics course. 21-355 is particularly recommended for student planning to pursue graduate study.

15-211 Fundamental Data Structures and Algorithms	12
15-212 Principles of Programming	12
21-270 Introduction to Mathematical Finance	9
21-355 Principles of Real Analysis I	9
21-365 Projects in Applied Mathematics	9
21-366 Topics in Applied Mathematics	9
21-370 Discrete Time Finance	9
21-373 Algebraic Structures	9
21-420 Continuous-Time Finance	9
21-484 Graph Theory	9
36-461 Topics in Statistics	9
36-462 Topics in Statistics	9
36-463 Topics in Statistics	9
36-464 Applied Multivariate Methods	9

Other Courses

	Units
15-110 Principles of Computing	10
15-121 Introduction to Data Structures	10
73-100 Principles of Economics	9
	29

(114 units, including)

73-100

MCS humanities, social science, and science core
four free electives

Suggested Schedule

Freshman Year

Fall		Units
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
15-110	Principles of Computing	10
03-121	Modern Biology	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		<hr/>
		53

Spring		Units
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics II for Science Students	12
09-105	Introduction to Modern Chemistry I	10
21-127	Concepts of Mathematics	9
xx-xxx	H&SS Elective	9
		<hr/>
		50

Sophomore Year

Fall		Units
21-228	Discrete Mathematics (21-301)	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergrad Colloquium	1
73-100	Principles of Economics	9
		<hr/>
		37

Spring		Units
15-121	Introduction to Data Structures	10
21-260	Differential Equations	9
21-292	Operations Research I	9
21-201	Undergrad Colloquium	1
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		<hr/>
		47

Junior Year

Fall		Units
21-369	Numerical Methods	9
36-225	Introduction to Probability Theory	9
	or 21-325 Probability (9 units)	
xx-xxx	Depth Elective	9
xx-xxx	Depth Elective	9
xx-xxx	H&SS Elective	9
		<hr/>
		45

Spring		Units
xx-xxx	Depth Elective	9
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Modeling	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Senior Year

Fall		Units
21-393	Operations Research II	9
36-401	Modern Regression	9
xx-xxx	Depth Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective 4	9
		<hr/>
		45

Spring		Units
36-402	Advanced Data Analysis	9
xx-xxx	Depth Analysis	9
xx-xxx	Depth Analysis	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Minimum number of units required for the degree: 360

Discrete Mathematics and Logic Concentration

This concentration will enable the student to develop mathematical skills in the areas of discrete mathematics and mathematical logic while simultaneously preparing the student for graduate study in mathematics, computer science or related disciplines. Both discrete mathematics and logic have strong ties with theoretical computer science, philosophy and computer engineering. This concentration is particularly recommended for students planning careers in computer science or engineering who wish to improve their understanding of the mathematical foundation of recent and future technological advancements in these fields.

The requirements for the Discrete Mathematics and Logic Concentration are:

Mathematical Sciences and Computer Science (122 units)

		Units
15-121	Introduction to Data Structures	10
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	12
21-120	Differential and Integral Calculus	10
	or 21-131 Analysis I (10 units)	
21-122	Integration, Differential Equations and Approximation	10
	or 21-132 Analysis II (10 units)	
21-127	Concepts of Mathematics	9
21-201	Undergrad Colloquium	1
21-300	Basic Logic	9
21-301	Combinatorics	9
21-341	Linear Algebra	9
21-355	Principles of Real Analysis I	9
21-374	Field Theory	9
21-484	Graph Theory	9
		<hr/>
		118

Discrete Mathematics and Logic

Three of the following: (27 to 36 units)		
21-329	Set Theory	9
21-374	Field Theory	9
80-405	Game Theory	9
80-411	Proof 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

Computer Science electives: (18 units)

Any two courses at the 300 level or above. The following are specifically suggested:

15-312	Foundations of Programming Languages	12
15-451	Algorithm Design and Analysis	12
15-453	Formal Languages, Automata, and Computability	9

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.

Technical Electives: (36 units)

Any four Mathematical Sciences courses at the 300 level or above, or from the following list:

21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-292	Operations Research I	9
36-217	Probability Theory and Random Processes	9
80-405	Game Theory	9
80-411	Proof Theory	9
80-413	Category Theory	9

Other Courses:

MCS Humanities, Science and Computer Skills Core: (114 units) Free Electives: (Sufficient to meet minimum requirement of 360 units.)

Suggested Schedule

Freshman Year

Fall		Units
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
15-121	Introduction to Data Structures	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		<hr/> 44

Spring		Units
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics II for Science Students	12
09-105	Introduction to Modern Chemistry I	10
		<hr/> 41

Sophomore Year

Fall		Units
15-211	Fundamental Data Structures and Algorithms	12
21-301	Combinatorics	9
21-341	Linear Algebra	9
21-201	Undergrad Colloquium	1
03-121	Modern Biology	9
xx-xxx	Humanities Elective	9
		<hr/> 49

Spring		Units
15-212	Principles of Programming	12
xx-xxx	Discrete Math/Logic	9
21-201	Undergrad Colloquium	1
xx-xxx	Technical Elective	9
xx-xxx	Humanities Elective	9
xx-xxx	Humanities Elective	9
		<hr/> 49

Junior Year

Fall		Units
15-xxx	Computer Science Elective	9
21-300	Basic Logic	9
21-355	Principles of Real Analysis I	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/> 45

Spring		Units
15-xxx	Computer Science Elective	9
21-373	Algebraic Structures	9
21-484	Graph Theory	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/> 45

Senior Year

Fall		Units
xx-xxx	Discrete Math/Logic	9
xx-xxx	Technical Elective	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		<hr/> 45

Spring		Units
xx-xxx	Discrete Math/Logic	9
xx-xxx	Technical Elective	18
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/> 45

Minimum number of units required for degree: 360

Computational and Applied Mathematics Concentration

This concentration is designed to prepare students for careers in business or industry requiring significant skills in computation and problem solving. Beginning at the level of quantifying or modeling a problem, students will develop skills in 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: (101 Units)

		Units
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-201	Undergrad Colloquium	1
21-228	Discrete Mathematics	9
	or 21-301 Combinatorics (9 units)	
	or 21-484 Graph Theory (9 units)	
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-320	Symbolic Programming Methods	9

21-355	Principles of Real Analysis I	9
21-356	Principles of Real Analysis II	9
	or 21-357 Sequences and Series of Functions (9 units)	
21-369	Numerical Methods	9
		<hr/>
		102

Five of the following distribution courses:

(A minimum of 45 units)

15-211	Fundamental Data Structures and Algorithms	12
21-292	Operations Research I	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
21-476	Ordinary Differential Equations	9
21-470	Selected Topics in Analysis *	9
21-660	Introduction to Numerical Analysis I	12
21-690	Methods of Optimization	12
21-xxx	Mathematical Science Elective	
36-410	Introduction to Probability Modeling	9

* Topics have included the following (student may take more than one):

- Calculus of Variations
- Finite Difference Equations

Other Courses: (19 units)

15-121	Introduction to Data Structures	10
36-225	Introduction to Probability Theory	9
	or 21-325 Probability (9 units)	
		<hr/>
		19

MCS humanities, science and computer skills course (114 units)

Free electives (sufficient to meet minimum of 360 units)

Suggested Schedule

Freshman Year

Fall		Units
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
15-121	Introduction to Data Structures	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
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		44

Spring		Units
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics II for Science Students	12
09-105	Introduction to Modern Chemistry I	10
xx-xxx	Humanities Elective	9
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Sophomore Year

Fall		Units
03-121	Modern Biology	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergrad Colloquium	1
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/>
		46

Spring		Units
21-228	Discrete Mathematics	9
	or 21-301 Combinatorics (9 units)	
	or 21-484 Graph Theory (9 units)	
21-260	Differential Equations	9
21-201	Undergrad Colloquium	1
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/>
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Junior Year

Fall		Units
21-320	Symbolic Programming Methods	9
21-355	Principles of Real Analysis I	9
36-225	Introduction to Probability Theory	9
	or 21-325 Probability (9 units)	
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Spring		Units
21-356	Principles of Real Analysis II	9
21-369	Numerical Methods	9
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Senior Year

Fall		Units
xx-xxx	Distribution Course	9
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Spring		Units
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		<hr/>
		45

Minimum units required for degree: 360

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 Undergrad 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 or equivalent courses. Students planning to include

21-373 Algebraic Structures as a Mathematical Sciences Elective should choose 21-341 Linear Algebra , 21-241 and 21-341 cannot both count toward the minor.

21-127	Concepts of Mathematics	9
21-228	Discrete Mathematics	9
	or21-301 Combinatorics (9 units)	
	or21-484 Graph Theory (9 units)	
21-241	Matrix Algebra	9
	or21-341 Linear Algebra (9 units)	
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 Science 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. Excluded as acceptable electives are the following: 21-105 , 21-111 , 21-112 , 21-120 , 21-122 , 21-259 , and 21-260 , and courses intended for H&SS or undergraduate business students, such as 21-110 , 21-256 and 21-257 .

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
21-374	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.

Honors Program Requirements:

21-901	Masters Degree Research	Var.
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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 five graduate course must include at least one course from each of the following areas:

- Analysis, e.g., Measure and Integration, Complex Analysis, Functional Analysis
- Algebra, Logic, Geometry and Topology, e.g., Mathematical Logic I, Algebra I, General Topology, Discrete Mathematics, Commutative Algebra
- Applied Mathematics, e.g., Introduction to Continuum Mechanics, Probability Measures, Probability Theory, Graphs and Network Flows, Ordinary Differential Equations, Methods of Optimization, Introduction to Numerical Analysis I.

Faculty

PETER B. ANDREWS, Professor 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.

MANUEL BLUM, University Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1999.

TOM BOHMAN, Professor Ph.D., Rutgers University; Carnegie Mellon, 1998.

DEBORAH BRANDON, Associate Teaching Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991.

CHARLES V. COFFMAN, Emeritus Ph.D., Johns Hopkins University; Carnegie Mellon, 1962.

GERARD CORNUEJOLS, University Professor Ph.D., Cornell University; Carnegie Mellon, 1978.

JAMES CUMMINGS, Professor Ph.D., Cambridge University; Carnegie Mellon, 1996.

HASAN DEMIRKOPARAN, Assistant Teaching Professor Ph.D., Michigan State University; Carnegie Mellon, 2005.

ANDRZEJ DUDEK, Nehari Visiting Assistant Professor Ph.D., Emory University; Carnegie Mellon, 2008.

TIMOTHY FLAHERTY, Assistant Teaching Professor Ph.D., University of Pittsburgh,; Carnegie Mellon, 1999.

IRENE M. FONSECA, Professor Ph.D., University of Minnesota; Carnegie Mellon, 1987.

ALAN M. FRIEZE, Professor Ph.D., University of London; Carnegie Mellon, 1987.

IRINA GHEORGHIUC, Assistant Teaching Professor Ph.D., University of Pennsylvania; Carnegie Mellon, 2007.

JAMES M. GREENBERG, Emeritus Ph.D., Brown University; Carnegie Mellon, 1995.

RAMI GROSSBERG, Professor Ph.D., Hebrew University of Jerusalem; Carnegie Mellon, 1988.

MORTON E. GURTIN, Emeritus Ph.D., Brown University; Carnegie Mellon, 1966.

DAVID HANDRON, Assistant Teaching Professor Ph.D., Rice University; Carnegie Mellon, 1999.

WILLIAM J. HRUSA, Professor Ph.D., Brown University; Carnegie Mellon, 1982.

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.

DAVID KINDERLEHRER, Professor Ph.D., University of California at Berkeley; Carnegie Mellon, 1990.

DMITRY KRAMKOV, Professor Ph.D., Steklov Mathematical Institute; Carnegie Mellon, 2000.

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.

RICHARD C. MACCAMY, Emeritus Ph.D., University of California at Berkeley; Carnegie Mellon, 1956.

JOHN MACKEY, Associate 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. OLIVER, Associate 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.

OLEG PIKHURKO, Associate Professor Ph.D., Cambridge University; Carnegie Mellon, 2003.

AGOSTON PISZTORA, Associate Professor Ph.D., ETH Zurich; Carnegie Mellon, 1996.

JOHN W. SCHAEFFER, Professor Ph.D., Indiana University; Carnegie Mellon, 1983.

JUAN J. SCHÄFFER, Professor Ph.D., Universität Zürich; Carnegie Mellon, 1968.

ERNEST SCHIMMERLING, Associate 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, Assistant Professor Ph.D., University of Texas at Austin; Carnegie Mellon, 2006.

RICHARD STATMAN, Professor Ph.D., Stanford University; Carnegie Mellon, 1984.

SHLOMO TA'ASAN, Professor Ph.D., Weizmann Institute; Carnegie Mellon, 1994.

LUC TARTAR, University Professor Ph.D., University of Paris; Carnegie Mellon, 1987.

RUSSELL C. WALKER, Teaching Professor D.A., Carnegie Mellon University; Carnegie Mellon, 1984.

NOEL S. WALKINGTON, Professor Ph.D., University of Texas at Austin; Carnegie Mellon, 1989.

WILLIAM O. WILLIAMS, Professor Ph.D., Brown University; Carnegie Mellon, 1966.

DALE WINTER, Visiting Teaching Professor Ph.D., University of Michigan, Ann Arbor; Carnegie Mellon, 2008.

Department of Physics

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 Student Programs Office: Wean Hall 7319

<http://www.cmu.edu/physics>

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 wideranging program of advising. Beyond aiding in academic planning, 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 not only from a wide variety of intermediate and advanced topics in physics, but also from 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.

Requirements

Physics Courses	
33-104	Experimental Physics ⁽¹⁾ 9
33-111	Physics I for Science Students 12
	or 33-131 Matter and Interaction I (12 units)
33-112	Physics II for Science Students 12
	or 33-132 Matter and Interactions II (12 units)
33-201 & 33-202	Physics Sophomore Colloquium I-II 4
33-301 & 33-302	Physics Upperclass Colloquium I-II 2
33-211	Physics III: Modern Essentials 10
33-228	Electronics I 10
33-231	Physical Analysis 9
33-232	Mathematical Methods of Physics 9
33-234	Quantum Physics 10
33-331	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 - at least 36 units ⁽²⁾⁽³⁾ 36
	Minimum Total Physics Units ⁽⁴⁾ 163

Mathematics Courses	
21-120	Differential and Integral Calculus 10
21-122	Integration, Differential Equations and Approximation 10
21-259	Calculus in Three Dimensions 9
	Mathematics Electives (at least 9 units) ⁽⁵⁾ 9
	Total Mathematics Units ⁽⁴⁾ 38

Mellon College of Science Core ⁽⁶⁾	
03-121	Modern Biology 9
09-105	Introduction to Modern Chemistry I 10
15-110	Principles of Computing ⁽⁷⁾ 10
99-10x	Computing @ Carnegie Mellon 3
	Total MCS Core 32

	Humanities, Social Sciences, or Fine Arts Courses ⁽⁴⁾⁽⁸⁾ 72
	Technical Electives ⁽⁴⁾⁽⁹⁾ 27
	Free electives ⁽⁴⁾⁽¹⁰⁾ 28

The minimum number of units required for this degree: 360

Notes:

(1) Experimental Physics must be taken no later than the fall semester of the sophomore year.

(2) Qualifying electives in physics are listed below.

(3) Students planning to undertake graduate study in physics are strongly advised to take Physical Mechanics II (33-332), Intermediate Electricity and Magnetism II (33-339), Adv Quantum Physics I (33-445), and Advanced Quantum Physics II (33-446).

(4) Any excess units earned in physics or mathematics courses count towards the technical units, and excess technical or H&SS/FA units count towards free elective units.

(5) Chosen from any 21-2xx or higher level course except History of Mathematics (21-350). Note that Mathematical Methods of Physics (33-232) may be taken instead of Differential Equations (21-260) as a prerequisite for any math course.

(6) The MCS core courses may be taken in any order, but must be finished by the end of the junior year.

(7) 15-110 Principles of Computing or equivalent as pre-approved by the Associate Dean of Mellon College of Science.

(8) Humanities, Social Sciences and Fine Arts (H&S/FA) requirements follow the Mellon College of Science guidelines.

(9) Technical electives are any courses in MCS, SCS, Statistics, and CIT, and others explicitly approved by the Physics Department.

(10) A free elective is any Carnegie Mellon course. However, a maximum of 9 units of physical education and/or military science and/or or StuCo courses may be taken as free electives.

Qualifying Electives in Physics for the B.S. Degree

Fall and Spring		
33-350	Undergraduate Research ⁽¹¹⁾	Var.
33-398	Special Topics ⁽¹²⁾	9
33-451	Senior Research ⁽¹¹⁾	Var.
33-499	Supervised Reading ⁽¹¹⁾	Var.

Fall Only		
33-224	Stars, Galaxies and the Universe	9
33-241	Introduction to Computational Physics	9
33-441 /03-439	Introduction to BioPhysics	10
33-445	Adv Quantum Physics I	9
33-467	Astrophysics of Stars and the Galaxy	9
33-650	General Relativity	9

Spring Only		
33-114	Physics of Musical Sound ⁽¹³⁾	9
33-332	Physical Mechanics II	10
33-339	Intermediate Electricity and Magnetism II	10
33-342	Thermal Physics II	10
33-446	Advanced Quantum Physics II	9
33-448	Introduction to Solid State Physics	9
33-456	Advanced Computational Physics	9
33-466	Extragalactic Astrophysics and Cosmology	9

Fall Only (Alternate Years)		
33-353	Intermediate Optics (2010, 2012)	12
33-355	Nanoscience and Nanotechnology (2011, 2013)	9

Spring Only (Alternate Years)		
33-444	Introduction to Nuclear and Particle Physics (2011, 2013)	9
33-658	Quantum Computation and Quantum Information Theory (2012, 2014)	10

Graduate Courses		
33-755	Quantum Mechanics I	12
33-756	Quantum Mechanics II	12
33-758	Quantum Computation and Quantum Information Theory	12
33-759	Introduction to Mathematical Physics I	12
33-761	Classical Electrodynamics I	12
33-762	Classical Electrodynamics II	12

33-765	Statistical Mechanics	12
33-767	Biophysics: From Basic Concepts to Current Research	12
33-769	Quantum Mechanics III	12
33-770	Quantum Mechanics IV	12
33-771	Quantum Mechanics V	12
33-777	Introductory Astrophysics	12
33-779	Introduction to Nuclear and Particle Physics	12
33-780	Nuclear and Particle Physics II	12
33-783	Theory of Solids I	12

Notes:

(11) Only one of the two research courses — 33-350 (at least 9 units) and 33-451 (at least 9 units) — may be used to satisfy a Physics elective requirement. A maximum of 9 units of the reading course 33-499 can be used to satisfy a Physics elective. Any exception requires prior approval from the department.

(12) 33-398 Special Topics is offered occasionally and focuses on a variety of different topics; recent topics have included String Theory and Nanoscience and Nanotechnology.

(13) Physics of Musical Sound (33-114) serves as a qualifying physics elective for the BA program only. Any exception needs prior approval from the department.

B.S. in Physics Sample Schedule (No Track) First Year

Fall		
33-111	Physics I for Science Students or 33-131 Matter and Interaction I (12 units)	12
15-110	Principles of Computing	10
21-120	Differential and Integral Calculus	10
99-101	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument (MCS Core 1 of 8)	9

Spring		
33-112	Physics II for Science Students or 33-132 Matter and Interactions II (12 units)	12
33-104	Experimental Physics	9
21-122	Integration, Differential Equations and Approximation	10
xx-xxx	Humanities, Social Sciences, or Fine Arts Course (MCS Core 2 of 8)	9

Sophomore Year

Fall		
33-211	Physics III: Modern Essentials	10
33-231	Physical Analysis	9
33-201	Physics Sophomore Colloquium I	2
21-259	Calculus in Three Dimensions	9
09-105	Introduction to Modern Chemistry I	10
xx-xxx	H&S/FA Course (MCS Core 3 of 8)	9

Spring		
33-232	Mathematical Methods of Physics	9
33-228	Electronics I	10
33-234	Quantum Physics	10
33-202	Physics Sophomore Colloquium II	2
03-121	Modern Biology	9
xx-xxx	H&S/FA 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 Upperclass Colloquium I	1
xx-xxx	H&S/FA 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 Upperclass 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	H&SS/FA 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	H&SS/FA 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	H&SS/FA 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 B.A. academic advisor and construct an approved plan of study.

The requirements for the B.A. degree follow those for the B.S. degree with the following modifications:

- 18 units of Physics electives are required
- No units of mathematics electives are required.
- No units of technical electives are required.

The minimum number of units required for this degree is 360.

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. To that end, the student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and to choose computing, laboratory and applications electives that fulfill the requirements of the track.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-448 Introduction to Solid State Physics (9 units)
- 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 (at least 9 units) - may be taken as either of the following two courses:

33-350	Undergraduate Research	Var.
33-451	Senior Research	Var.

The topic in the research course must be in Applied Physics to be approved by the Assistant Head for Undergraduate Affairs. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

All courses chosen from the categories listed above must be pre-approved by the Assistant Head for Undergraduate Affairs.

Modifications from the requirements listed for the B.S. in Physics:

- No units of Physics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

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 requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-224 Stars, Galaxies and the Universe
- 33-467 Astrophysics of Stars and the Galaxy
- 33-466 Extragalactic Astrophysics and Cosmology
- One research course (at least 9 units) - may be taken as either of the following two courses:

33-350	Undergraduate Research	Var.
33-451	Senior Research	Var.

The topic in the research course must be in Astrophysics to be approved by the Assistant Head for Undergraduate Affairs. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

Modifications from the requirements listed for the B.S. in Physics:

- No units of Physics Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

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 postbaccalaureate 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 adapt 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 premedical program should consult with both the Assistant Head for Undergraduate Affairs in the Physics Department and the Director of the Health Professions Program for help in planning their programs.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-441/03-439 Introduction to Biophysics
- 03-231 Biochemistry I
- 09-217 Organic Chemistry I
- 09-218 Organic Chemistry II
- Two courses (at least 18 units) in Biological Sciences, to be preapproved by the Assistant Head for Undergraduate Affairs

Modifications from the requirements listed for the B.S. in Physics:

- Only one Physics Elective (at least 9 units) is required.
- No units of Technical Electives are required.
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

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 that 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 requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 09-106 Modern Chemistry II
- 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry
- 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry
- Three courses (at least 27 units) in Chemistry, to be preapproved by the Assistant Head for Undergraduate Affairs.

Modifications from the requirements listed for the B.S. in Physics:

- Only one Physics Elective (at least 9 units) is required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

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 that fulfill the requirements of the track.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-241 Introduction to Computational Physics
- 33-456 Advanced Computational Physics
- 21-127 Concepts of Mathematics
- 21-369 Numerical Methods
- 15-211 Fundamental Data Structures and Algorithms
- One of the following classes: 15-212 Principles of Programming, 15-213 Introduction to Computer Systems, 15-251 Great Theoretical Ideas in Computer Science

Modifications from the requirements listed for the B.S. in Physics:

- Only two Physics Electives (at least 9 units each) are required
- No units of Mathematics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

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 another subject and Physics — 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 Mathematics Elective are required
- 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, 99-10x Computing @ Carnegie Mellon.
- However, 15-110 Principles of Computing (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 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.

The 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 sequence consists of two introductory level courses followed by five electives chosen from the list below. The choice of electives requires prior approval by the Department of Physics, and should be made in close consultation with the Physics Department Assistant Head for Undergraduate Affairs. The Department intends to be flexible and accommodate the student's specific interests. 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 Differential and Integral Calculus, 21-122 Integration, Differential Equations and Approximation, 21-259 Calculus in Three Dimensions).

The Physics minor requires seven courses of at least 9 units each, of which four are required and three are electives.

Required Courses

I. Introductory Physics I

33-106	Physics I for Engineering Students	12
33-111	Physics I for Science Students	12
33-131	Matter and Interaction I	12

II. Introductory Physics II

33-107	Physics II for Engineering Students	12
33-112	Physics II for Science Students	12
33-132	Matter and Interactions II	12

III. Modern Physics

33-211	Physics III: Modern Essentials	10
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IV. Laboratory Experience

33-104	Experimental Physics	9
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Elective Courses

33-114	Physics of Musical Sound	9
33-224	Stars, Galaxies and the Universe	9
33-225	Quantum Physics and Structure of Matter	9
33-228	Electronics I	10
33-231	Physical Analysis	9
33-232	Mathematical Methods of Physics	9
33-234	Quantum Physics	10
33-241	Introduction to Computational Physics	9
33-331	Physical Mechanics I	10
33-332	Physical Mechanics II	10
33-338	Intermediate Electricity and Magnetism I	10
33-339	Intermediate Electricity and Magnetism II	10
33-340	Modern Physics Laboratory	10
33-341	Thermal Physics I	10
33-342	Thermal Physics II	10
33-350	Undergraduate Research	Var.
33-353	Intermediate Optics	12
33-355	Nanoscience and Nanotechnology	9
33-398	Special Topics	9
33-444	Introduction to Nuclear and Particle Physics	9
33-445	Adv Quantum Physics I	9
33-446	Advanced Quantum Physics II	9
33-448	Introduction to Solid State Physics	9
33-451	Senior Research	Var.
33-456	Advanced Computational Physics	9
33-466	Extragalactic Astrophysics and Cosmology	9
33-467	Astrophysics of Stars and the Galaxy	9
33-499	Supervised Reading	Var.
33-650	General Relativity	9
33-658	Quantum Computation and Quantum Information Theory	10

Any substitution of these requirements for the minor must be pre-approved in writing by the Physics Department.

Faculty

ROY A. BRIERE, Associate 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 DIMATTEO, 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.
 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 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.
 MAUMITA MANDAL, Assistant Professor of Chemistry Ph.D., Hyderabad, India; Carnegie Mellon, 2009.
 SARA A. MAJETICH, Professor of Physics Ph.D., University of Georgia; Carnegie Mellon, 1990.
 CURTIS A. MEYER, Professor of Physics Ph.D., University of California, Berkeley; Carnegie Mellon, 1993.
 COLIN J. MORNINGSTAR, Associate 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 PAULINI, Associate 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, 1988.
 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 F. SEKERKA, University Professor of Physics and Mathematics Ph.D., Harvard University; Carnegie Mellon, 1969.
 ROBERT M. SUTER, Professor of Physics Ph.D., Clark University; Carnegie Mellon, 1981.
 ROBERT H. SWENDSEN, 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, 1982.
 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.

Emeriti Faculty

LUC 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. KISSLINGER, 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.

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.

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, Assistant Professor, Mechanical Engineering Ph.D., Harvard University; Carnegie Mellon, 2003.

DAVID GREVE, Professor, Electrical and Computer Engineering Ph.D., Lehigh University; Carnegie Mellon, 1982.

MOHAMMAD F. ISLAM, Assistant Professor of Chemical 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.

MORTON KAPLAN, Professor, Chemistry Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970.

MICHAEL E. MCHENRY, Professor, Materials Science and Engineering Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989.

BENOIT MOREL, Adjunct Senior Lecturer, Engineering and Public Policy Ph.D., University of Geneva, Switzerland; Carnegie Mellon, 1993.

ANTHONY D. ROLLETT, Ph.D., Drexel University; Carnegie Mellon, 1995.

JIAN-GANG ZHU, Professor of Electrical and Computer Engineering Ph.D., University of California San Diego; Carnegie Mellon, 1997.

School of Computer Science

School of Computer Science

Randy Bryant, Dean
 Klaus Sutner, Associate Dean for Undergraduate Education
 Mark Stehlik, Assistant Dean for Undergraduate Education
 Undergraduate Office: GHC 5202
<http://www.csd.cs.cmu.edu/education/bscs/>

Carnegie Mellon founded one of the first Computer Science departments in the world in 1965. Today, the Computer Science Department forms the centerpiece of the School of Computer Science, and is joined by the Entertainment Technology Center, the Human-Computer Interaction Institute, the Institute for Software Research, the Lane Center for Computational Biology, the Language Technologies Institute, the Machine Learning Department, and the Robotics Institute. Together, these units make the School of Computer Science a world leader in research and education.

The B.S. program in Computer Science combines a solid core of Computer Science courses with the ability to gain substantial depth in another area through a required minor in a second subject. In addition, the curriculum provides numerous choices for science and humanities courses. As computing is a discipline with strong links to many fields, this provides students with unparalleled flexibility to pursue allied (or non-allied) interests. The curriculum's mathematics and probability component ensures that students have the formal tools to remain current as technologies and systems change, rather than be limited by a narrow focus on programming alone. At the same time, students gain insight into the practical issues of building and maintaining systems by participating in intensive project-oriented courses. Due to the tremendous number of ongoing research projects within the School, many students obtain part-time or summer jobs, or receive independent study credit, working on research while pursuing their undergraduate degree. Students seeking a research/graduate school career may pursue an intensive course of research, equivalent to four classroom courses, culminating in the preparation of a senior research honors thesis.

Students apply to, and are directly admitted into, the undergraduate program in Computer Science and, upon successful completion, are awarded a Bachelor of Science in Computer Science. Suitably prepared students from other Carnegie Mellon colleges are eligible to apply for internal transfer to the School of Computer Science and will be considered for transfer if space is available. Computation-oriented programs are also available within the Departments of Biology, Chemistry, Physics, Electrical and Computer Engineering, Information Systems, Philosophy, Psychology, and Design. We also offer a B.S. degree in Computational Biology and joint degrees with the College of Fine Arts in Computer Science and Arts as well as Music and Technology. SCS offers a double major in Human-Computer Interaction and minors in Language Technologies, Neural Computation, Robotics, and Software Engineering.

NOTE: Beginning in the Fall, 2010 semester, the Computer Science Department will be piloting three new courses (15-122, 15-150, 15-210) that will replace 15-121, 15-211, 15-212. Initially, these will be offered to, and required for, CS majors only. Depending on the evaluation of the pilot, they will be rolled out for the rest of campus.

Curriculum - B.S. in Computer Science

Computer Science

Computer Science Core:	Units
15-122 Principles of Imperative Computation (students with no prior programming experience take 15-110 & 15-122)	10
15-123 Effective Programming in C and UNIX	9
15-128 Freshman Immigration Course	1
15-211 Fundamental Data Structures and Algorithms	12
15-212 Principles of Programming	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:	
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
others as designated	

One Applications elective:	
15-313 Foundations of Software Engineering	12
15-322 /323 Introduction to Computer Music	9
15-381 Artificial Intelligence: Representation and Problem Solving	9
15-384 Robotic Manipulation	12
15-385 Computer Vision	9
15-415 Database Applications	12
15-462 Computer Graphics	12
10-601 Machine Learning	12
11-411 Natural Language Processing	12
others as designated	

One Logics & Languages elective:	
15-312 Foundations of Programming Languages	12
15-317 Constructive Logic	9
15-414 Bug Catching: Automated Program Verification and Testing	9
21-300 Basic Logic	9
80-311 Computability and Incompleteness	9
others as designated	

One Software Systems elective:	
15-410 Operating System Design and Implementation	12
15-411 Compiler Design	12
15-440 Distributed Systems	12
15-441 Computer Networks	12
others as designated	

Two Computer Science electives:	Units
These electives can be from any SCS department	18

Mathematics/Probability

Mathematics core:	
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-127 Concepts of Mathematics	9
21-241 Matrix Algebra	9
or 21-341 Linear Algebra (9 units)	

One of the following Probability courses:	
15-359 Probability and Computing	12
21-325 Probability	9
36-217 Probability Theory and Random Processes	9
36-225 Introduction to Probability Theory	9
36-625 Probability and Mathematical Statistics I	12

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 Experimental Chemistry (this 3-unit lab together with 09-105, Introduction to Modern Chemistry, satisfies the lab requirement)	3
15-321	Research Methods for Experimental Computer Science	Var.
27-100	Engineering the Materials of the Future	12
33-104	Experimental Physics	9
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
33-100	Basic Experimental Physics	6
33-124	Introduction to Astronomy	9
39-100	Special Topics: WHAT IS ENGINEERING?	9
39-200	Business for Engineers	12

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
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Required Minor

A sequence of courses proscribed 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.

Humanities and Arts Requirements

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
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B. Breadth Requirement (27 units)

Complete three courses, one each from Category 1, Category 2, and Category 3:

Category 1: Cognition, Choice and Behavior

70-311	Organizational Behavior	9
80-130	Introduction to Ethics	9
80-150	Nature of Reason	9
80-180	The Nature of Language	9
80-221	Philosophy of Social Science	9
80-230	Ethical Theory	9
80-241	Ethical Judgments in Professional Life	9
80-242	Conflict and Dispute Resolution	9
80-270	Philosophy of Mind	9
80-275	Metaphysics	9
80-281	Language and Thought	9
85-100	Introduction to Intelligence in Humans, Animals and Machines	9
85-102	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

36-303	Sampling, Survey and Society	9
70-332	Business, Society and Ethics	9
73-100	Principles of Economics	9
73-150	Intermediate Microeconomics	9
79-331	Body Politics: Women and Health in America	9
79-335	Drug Use and Drug Policy	9
79-350	88-326 Early Christianity	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
80-341	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

Category 3: Cultural Analysis

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 I: Earliest Times	9
	Origins of the Slave Trades	
79-240	The Development of American Culture	9
79-241	African American History I	9
79-242	African American History II	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
80-253	Continental Philosophy	9
80-254	Analytic Philosophy	9
80-255	Pragmatism	9
80-261	Empiricism and Rationalism	9
80-276	Philosophy of Religion	9
82-273	Introduction to Japanese Language and Culture	9
82-293	Introduction to Russian Culture	9
82-303	French Culture	9
82-304	The Francophone World	9
82-333	Introduction to Chinese Language and Culture	Var.
82-342	Spain: Language and Culture	9
82-343	Latin America: Language and Culture	9
82-344	U.S. Latinos: Language and Culture	9
82-345	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 currently acceptable and not acceptable courses can be found at <http://www.csd.cs.cmu.edu/education/bcs/hss.html>.

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:

Area	Courses	Units
Computer Science	14	148
Math/Statistics	5	47
Engineering/Science	4	36
Humanities/Arts	7	63
Minor/Free electives	7	63
Computing @ Carnegie Mellon	1	3
		360

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	9
76-101 Interpretation and Argument	9
99-10x Computing Skills Workshop	3
xx-xxx Science/Engineering Course	9
	51

Spring	Units
15-211 Fundamental Data Structures and Algorithms	12
15-251 Great Theoretical Ideas in Computer Science	12
21-122 Integration, Differential Equations and Approximation	10
xx-xxx Science/Engineering Course	9
xx-xxx Humanities and Arts Elective	9
	52

Sophomore Year

Fall	Units
15-123 Effective Programming in C and UNIX	9
15-212 Principles of Programming	12
21-241 Matrix Algebra	9
xx-xxx Science/Engineering Course	9
xx-xxx Humanities and Arts Elective	9
	48

Spring	Units
15-213 Introduction to Computer Systems	12
15-221 Technical Communication for Computer Scientists	9
15-xxx Computer Science Elective	9
xx-xxx Science/Engineering Course	9
xx-xxx Minor Requirement / Free Elective	9
	48

Junior Year

Fall	Units
15-451 Algorithm Design and Analysis	12
15-xxx Computer Science Elective	9
xx-xxx Probability Course	9
xx-xxx Humanities and Arts Elective	9
xx-xxx Minor Requirement / Free Elective	9
	48

Spring	Units
15-xxx Computer Science Elective	12
15-xxx Computer Science Elective	9
xx-xxx Humanities and Arts Elective	9
xx-xxx Minor Requirement / Free Elective	9
	39

Senior Year

Fall	Units
15-xxx Computer Science Elective	12
xx-xxx Humanities and Arts Elective	9
xx-xxx Minor Requirement / Free Elective	9
xx-xxx Minor Requirement / Free Elective	9
	39

Spring	Units
15-xxx Computer Science Elective	9
xx-xxx Humanities and Arts Elective	9
xx-xxx Minor Requirement / Free Elective	9
xx-xxx Minor Requirement / Free Elective	9
	36

Minimum number of units required for the degree: 360

Suggested Options

The flexibility in the curriculum allows many different schedules, of which the above is only one possibility. For those students looking for some additional guidance in navigating their elective options, we offer the following recommendations of elective choices that might be made for particular concentrations.

Artificial Intelligence

10-601 Machine Learning	12
15-381 Artificial Intelligence: Representation and Problem Solving	9
15-384 /385 Robotic Manipulation	12
80-300 Minds Machines, and Knowledge	9
85-211 Cognitive Psychology	9
85-213 Human Information Processing and Artificial Intelligence	9
85-419 Introduction to Parallel Distributed Processing	9

Cognitive Modeling

05-432 Cognitive Modeling and Intelligent Tutoring Systems	9
85-211 Cognitive Psychology	9
85-213 Human Information Processing and Artificial Intelligence	9
85-392 Human Expertise	9
85-412 Cognitive Modeling	9

Computer Systems

15-410	Operating System Design and Implementation	12
15-411	Compiler Design	12
15-412	Operating System Practicum	Var.
15-441	Computer Networks	12
15-610	Engineering Complex, Large-Scale Computer Systems	12
18-240	Structure and Design of Digital Systems	12
18-447	Introduction to Computer Architecture	12

Entrepreneurship

15-390	Entrepreneurship for Computer Science	9
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Graphics/Virtual Reality

05-331	Building Virtual Worlds	24
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

Human-Computer Interaction

05-410	Human-Computer Interaction Methods	12
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Additionally, students who are interested in Human-Computer Interaction are encouraged to look at the description of the Double Major in Human-Computer Interaction at page 66

Language Technologies

15-482	Human Language Technologies	12
80-180	The Nature of Language	9

Additionally, students interested in Language Technologies are encouraged to look at the description of the Minor in Language Technologies and the Minor in Linguistics at page 193

Robotics

16-311	Introduction to Robotics	12
16-362	Mobile Robot Programming Laboratory	12

Additionally, students who are interested in Robotics are encouraged to look at the description of the Minor in Robotics at page 66

Scientific Computation

21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-320	Symbolic Programming Methods	9
21-369	Numerical Methods	9
36-410	Introduction to Probability Modeling	9

Additionally, students who are interested in Scientific Computation are encouraged to look at the description of the Minor in Scientific Computing at page 275 as well as the following discipline-specific Computational Science courses:

03-310	Introduction to Computational Biology	12
09-560	Molecular Modeling and Computational Chemistry	12
33-241	Introduction to Computational Physics	9

Software Systems

15-312	Foundations of Programming Languages	12
15-410	Operating System Design and Implementation	12
15-411	Compiler Design	12
15-415	Database Applications	12
15-441	Computer Networks	12

Theory

15-312	Foundations of Programming Languages	12
15-453	Formal Languages, Automata, and Computability	9
15-85x	Graduate Theory course	
21-301	Combinatorics	9
21-341	Linear Algebra	9
21-355	Principles of Real Analysis I	9
21-373	Algebraic Structures	9
21-484	Graph Theory	9
21-600	Mathematical Logic I	12

Graduate School Preparation

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. Additionally, graduate CS courses can be taken with permission of the instructor.

Senior Research Thesis

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.

Computer Science as a Secondary Concentration

The School of Computer Science offers a Double Major in Computer Science and Minors in Computer Science, Language Technologies, and Robotics. It also jointly offers a Double Major in Human-Computer Interaction.

Double Major in Computer Science

The following courses are required for the Double Major in Computer Science:

Prerequisites:		Units
15-121	Introduction to Data Structures (students with no prior programming experience take 15-110 & 15-121)	10
15-123	Effective Programming in C and UNIX	9
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
21-241	Matrix Algebra	9
or 21-341 Linear Algebra (9 units)		

Computer Science core:		Units
15-211	Fundamental Data Structures and Algorithms	12
15-212	Principles of Programming	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	Mandatory Computer Science core course:	Units
15-221 Technical Communication for Computer Scientists	9	15-211 Fundamental Data Structures and Algorithms	12

One Algorithms & Complexity elective:		One of the following Computer Science core courses:	
15-354 Computational Discrete Mathematics	12	15-213 Introduction to Computer Systems (requires 15-123 as a prerequisite)	12
15-355 Modern Computer Algebra	9	15-251 Great Theoretical Ideas in Computer Science	12
15-453 Formal Languages, Automata, and Computability	9		
21-301 Combinatorics	9		
21-484 Graph Theory	9		
others as designated			

One Applications elective:		Three Computer Science electives:	Units
15-313 Foundations of Software Engineering	12	These elective courses must be 15-212 or higher (except 15-221, which cannot be used); one can be from any SCS department, with prior approval	27
15-322 /323 Introduction to Computer Music	9		
15-381 Artificial Intelligence: Representation and Problem Solving	9		
15-384 Robotic Manipulation	12		
15-385 Computer Vision	9		
15-415 Database Applications	12		
15-462 Computer Graphics	12		
10-601 Machine Learning	12		
11-411 Natural Language Processing	12		
others as designated			

Double-Counting Restriction

In order to avoid excessive double-counting, students pursuing a Double Major or Minor in Computer Science must complete at least 6 courses in their home department, of at least 9 units each, none of which are required by (or are cognates for requirements in) the Computer Science major.

One Logics & Languages elective:	
15-312 Foundations of Programming Languages	12
15-317 Constructive Logic	9
15-414 Bug Catching: Automated Program Verification and Testing	9
21-300 Basic Logic	9
80-311 Computability and Incompleteness	9
others as designated	

Language Technologies Minor

The following courses are required for the Minor in Language Technologies:

Prerequisites:

15-121 Introduction to Data Structures (students with no prior programming experience take 15-110 & 15-121)	10
21-127 Concepts of Mathematics	9
15-211 Fundamental Data Structures and Algorithms	12
15-212 Principles of Programming	12
15-251 Great Theoretical Ideas in Computer Science	12

One Software Systems elective:	
15-410 Operating System Design and Implementation	12
15-411 Compiler Design	12
15-440 Distributed Systems	12
15-441 Computer Networks	12
others as designated	

Minor requirements:

Both of the following courses:	
15-482 Human Language Technologies	12
11-721 Grammars and Lexicons	12

Two Computer Science electives:	Units
These electives can be from any SCS department	18

Two of the following electives:	
11-411 Natural Language Processing	12
11-617 Language Technologies for Computer Assisted Language Learning	12
11-711 Algorithms for NLP	12
11-731 Machine Translation	12
11-741 Information Retrieval	12
11-751 Speech Recognition and Understanding	12
11-752 Speech II: Phonetics, Prosody, Perception and Synthesis	12
11-761 Language and Statistics	12
15-482 Human Language Technologies	12
80-180 The Nature of Language	9
80-280 Linguistic Analysis	9

Minor in Computer Science

The following courses are required for the Minor in Computer Science:

Prerequisites:	Units
15-121 Introduction to Data Structures (students with no prior programming experience take 15-110 & 15-121)	10
21-127 Concepts of Mathematics	9

A semester-long directed research project

More information on the required research project, and on the minor, can be found at http://www.lti.cs.cmu.edu/lti_minor.

Double-Counting Restriction

CS majors may use 15-482 as an elective for their CS major and also as a required course for the Language Technologies Minor. Courses in the Language Technologies Minor may not also be counted towards another SCS minor.

Robotics Minor

The following courses are required for the Minor in Robotics:

Prerequisites:

15-121	Introduction to Data Structures (students with no prior programming experience take 15-110 & 15-121)	10
15-123	Effective Programming in C and UNIX	9

Minor requirements:

Both of the following courses:

15-384	Robotic Manipulation	12
16-311	Introduction to Robotics	12

One of the following courses:

16-299	Introduction to Feedback Control Systems	12
18-370	Fundamentals of Control	12
24-452	Mechanical Systems Experimentation	9

Two of the following electives:

15-381	Artificial Intelligence: Representation and Problem Solving	9
15-385	Computer Vision	9
15-462	Computer Graphics	12
15-463	Computational Photography	12
16-362	Mobile Robot Programming Laboratory	12
16-721	Learning-based Methods in Vision	12
16-735	Robotic Motion Planning	12
16-778	Mechatronic Design	12
10-601	Machine Learning	12
60-422	Advanced ETB: Robotic Art Studio	10
85-213	Human Information Processing and Artificial Intelligence	9
85-370	Perception	9

More information on the minor can be found at http://www.ri.cmu.edu/education/ugrad_minor.html.

Double-Counting Restriction

Courses in the Robotics Minor may not also be counted towards another SCS minor.

Software Engineering Minor

The following courses are required for the Minor in Software Engineering:

Prerequisites

15-211	Fundamental Data Structures and Algorithms	12
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Plus one of the following:

15-212	Principles of Programming	12
15-213	Introduction to Computer Systems	12

Core Course Requirements

15-313	Foundations of Software Engineering	12
15-413	Software Engineering Practicum	12

Electives

1. One domain-independent course focused on technical software engineering material:

15-414	Bug Catching: Automated Program Verification and Testing	9
Other courses, with prior approval from the Director of the Software Engineering Masters Program		

2. One engineering-focused course with a significant software component:

05-540	Rapid Prototyping of Computer Systems	12
15-410	Operating System Design and Implementation	12
15-412	Operating System Practicum	Var.
15-437	Web Application Development	12
15-441	Computer Networks	12
18-549	Embedded Systems Design	12
18-649	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:

08-533	Privacy, Policy, Law and Technology	9
15-390	Entrepreneurship for Computer Science	9
15-421	Web Commerce, Security and Privacy	12
19-402	Telecommunications, Technology Policy & Management	12
70-311	Organizational Behavior	9
70-414	Technology Based Entrepreneurship for CIT	9
70-459	Web Business Engineering	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.

17-413 Internship Reflection (required 6 unit course, number to be determined, to be offered Fall semester)

Each student will write an issue-focused reflection and analysis of some personal software engineering experience, typically (but not always) based on the engineering internship above. This report must be passed by one SCS faculty member and one SE Ph.D. student, for both technical content and effective written communication. Initial course meetings will cover the reflective, writing, and speaking process. In later meetings, each student will present his or her experience through a 30-45 minute talk, which will be evaluated for communication skills and critical reflective content. This course is limited to enrollment of 16, and students who are admitted to the minor program are given first priority.

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.

For more information, visit <http://www.cs.cmu.edu/~aldrich/se-minor/>

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 page 39

Dean's List

SCS recognizes each semester those undergraduates who have earned outstanding academic records by naming them to the Dean's List. The criterion 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 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 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 assistant dean for undergraduate education,
2. Completing a Return from Leave form from the Registrar's Office, and
3. Providing transcripts and clearance forms if the student has been in a degree program at another college or university. Academic credit earned in such circumstances will not transfer back to Carnegie Mellon.

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 after returning to school is 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 normal, not binding. In unusual circumstances, the 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 15-211 Fundamental Data Structures and Algorithms. 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 course work.
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

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, Assistant Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2005.

JOHN ANDERSON, Walter Vandyke Bingham Professor Ph.D., Stanford University; Carnegie Mellon, 1978.

DIMITRIOS APOSTOLOPOULOS, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989.

CHRISTOPHER ATKESON, Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2000.

JAMES BAGNELL, Associate Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004.

JOHN BARES, Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993.

ZIV BAR-JOSEPH, Associate Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2003.

MARCEL BERGERMAN, Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005.

HANS BERLINER, Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969.

ALAN BLACK, Associate Professor Ph.D., University Of Edinburgh; Carnegie Mellon, 1999.

GUY BLELLOCH, 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.

- DANIEL BOYARSKI, Professor and Head, School of Design M.F.A., Indiana University; Carnegie Mellon, 1982.
- STEPHEN BROOKES, Professor Ph.D., University College; Carnegie Mellon, 1981.
- RALF BROWN, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993.
- BRETT BROWNING, Senior Systems Scientist Ph.D., University of Queensland; Carnegie Mellon, 2000.
- RANDAL BRYANT, University Professor and Dean, School of Computer Science Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1984.
- JAMES CALLAN, Professor Ph.D., University Of Massachusetts; Carnegie Mellon, 1999.
- JALME CARBONELL, Allen Newell Professor, Director, Language Technologies Institute Ph.D., Yale University; Carnegie Mellon, 1979.
- KATHLEEN CARLEY, Professor Ph.D., Harvard University; Carnegie Mellon, 2002.
- JACOBO CARRASQUEL, Associate Teaching Professor M.S., Carnegie Mellon University; Carnegie Mellon, 1984.
- JUSTINE CASSELL, Professor and Department Head, Human-Computer Interaction Ph.D., University of Chicago; Carnegie Mellon, 1991.
- HOWARD CHOSET, Associate Professor Ph.D., California Institute Of Technology; Carnegie Mellon, 1996.
- MICHAEL CHRISTEL, Senior Systems Scientist Ph.D., Georgia Institute Of Technology; Carnegie Mellon, 1987.
- EDMUND CLARKE, Fore Systems Professor Of Computer Science Ph.D., Cornell University; Carnegie Mellon, 1982.
- WILLIAM COHEN, Associate Research Professor Ph.D., Rutgers University; Carnegie Mellon, 2003.
- ERIC COOPER, Distinguished Service Professor Ph.D., University Of California At Berkeley; Carnegie Mellon, 1985.
- SETH COPEN GOLDSTEIN, Associate Professor Ph.D., University Of California; Carnegie Mellon, 1997.
- ALBERT CORBETT, Associate Research Professor Ph.D., University Of Oregon; Carnegie Mellon, 1983.
- THOMAS CORTINA, Associate Teaching Professor Ph.D., Polytechnic University; Carnegie Mellon, 2004.
- LORRIE CRANOR, Associate Professor Ph.D., Washington University; Carnegie Mellon, 2003.
- KARL CRARY, Associate Professor Ph.D., Cornell University; Carnegie Mellon, 1998.
- WANDA DANN, Associate Teaching Professor Ph.D., Syracuse University; Carnegie Mellon, 2008.
- ROGER DANNENBERG, Associate Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982.
- FERNANDO DE LA TORRE FRADE, Assistant Research Professor Ph.D., La Salle School of Engineering; Carnegie Mellon, 2002.
- MARK DERTHICK, Assistant Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995.
- ANIND DEY, Associate Professor Ph.D., Georgia Institute Of Technology; Carnegie Mellon, 2005.
- M BERNARDINE DIAS, Assistant Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003.
- ANTHONY DIGIOIA, Associate Research Professor M.D., Harvard Medical School; Carnegie Mellon, 1999.
- JOHN DOLAN, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991.
- ARTUR DUBRAWSKI, Senior Systems Scientist Ph.D., Institute of Fundamental Technological Research; Carnegie Mellon, 1995.
- DAVID ECKHARDT, Associate Teaching Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003.
- WILLIAM EDDY, Professor Ph.D., Yale University; Carnegie Mellon, 1976.
- ALEXEI EFROS, Associate Professor Ph.D., University Of California At Berkeley; Carnegie Mellon, 2004.
- JEFFREY EPPINGER, Professor Of The Practice Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001.
- MICHAEL ERDMANN, Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1989.
- MAXINE ESKENAZI, Associate Teaching Professor Ph.D., University Of Paris; Carnegie Mellon, 1994.
- SCOTT FAHLMAN, Research Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1978.
- CHRISTOS FALOUTSOS, Professor Ph.D., University Of Toronto; Carnegie Mellon, 1997.
- DAVID FARBER, Distinguished Career Professor M.S., Stevens Institute Of Technology; Carnegie Mellon, 2002.
- DAVID FEINBERG, Assistant Teaching Professor M.Eng., Eng., Massachusetts Institute Of Technology; Carnegie Mellon, 2008.
- STEPHEN FIENBERG, Maurice Falk University Professor Ph.D., Harvard University; Carnegie Mellon, 1980.
- EUGENE FINK, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003.
- JODI FORLIZZI, Associate Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000.
- ROBERT FREDERKING, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991.
- DAVID GARLAN, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990.
- ANATOLE GERSHMAN, Research Professor Ph.D., Yale University; Carnegie Mellon, 2007.
- HARTMUT GEYER, Assistant Professor Ph.D., Friedrich-Schiller University; Carnegie Mellon, 2005.
- ZOUBIN GHAHRAMANI, Associate Research Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002.
- GARTH GIBSON, Professor Ph.D., University Of California; Carnegie Mellon, 1991.
- CLARK GLYMOUR, Alumni University Professor Ph.D., Indiana University; Carnegie Mellon, 1985.
- GEOFFREY GORDON, Associate Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001.
- REID GORDON SIMMONS, Research Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988.
- CARLOS GUESTRIN, Associate Professor Ph.D., Stanford University; Carnegie Mellon, 2004.
- VENKATESAN GURUSWAMI, Associate Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001.
- ANANDA GUNAWARDENA, Associate Teaching Professor Ph.D., Ohio University; Carnegie Mellon, 1998.
- ANUPAM GUPTA, Associate Professor Ph.D., University Of California At Berkeley; Carnegie Mellon, 2002.
- MOR HARCHOL-BALTER, Associate Professor Ph.D., University Of California; Carnegie Mellon, 1999.
- ROBERT HARPER, Professor Ph.D., Cornell University; Carnegie Mellon, 1988.
- ALEXANDER HAUPTMANN, Senior Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994.
- MARTIAL HEBERT, Professor Ph.D., Paris-XI; Carnegie Mellon, 1984.
- JAMES HERBSLEB, Professor Ph.D., University Of Nebraska; Carnegie Mellon, 2002.
- ALEX HILLS, Distinguished Service Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992.
- JESSICA HODGINS, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000.
- TIMOTHY HOFFMAN, Assistant Teaching Professor M.S., University Of Pittsburgh; Carnegie Mellon, 2000.
- RALPH HOLLIS, Research Professor Ph.D., University Of Colorado; Carnegie Mellon, 1993.
- JASON HONG, Associate Professor Ph.D., University Of California At Berkeley; Carnegie Mellon, 2004.
- DANIEL HUBER, Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002.
- SCOTT HUDSON, Professor Ph.D., University Of Colorado; Carnegie Mellon, 1997.

- BRANISLAV JARAMAZ, Associate Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997.
- BONNIE JOHN, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989.
- ANGEL JORDAN, Keithley University Professor Emeritus Ph.D., Stanford University; Carnegie Mellon, 1985.
- MATTHEW KAM, Assistant Professor Ph.D., University Of California At Berkeley; Carnegie Mellon, 2008.
- TAKEO KANADE, UA And Helen Whitaker University Professor Ph.D., Kyoto University; Carnegie Mellon, 1980.
- GEORGE KANTOR, Systems Scientist Ph.D., University of Maryland; Carnegie Mellon, 1999.
- THOMAS KEATING, Assistant Teaching Professor M.S., Duquesne University; Carnegie Mellon, 1988.
- ALONZO KELLY, Associate Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1998.
- GREGORY KESDEN, Associate Teaching Professor M.S., Clemson University; Carnegie Mellon, 1999.
- SEYOUNG KIM, Assistant Professor Ph.D., University of California AT Irvine; Carnegie Mellon, 2007.
- PRADEEP KHOSLA, Philip And Marsha Dowd Professor, Head, Department Of Electrical And Computer Engineering Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986.
- SARA KIESLER, Professor Ph.D., Ohio State University; Carnegie Mellon, 1979.
- ANIKET KITTUR, Assistant Professor Ph.D., University of California At Los Angeles; Carnegie Mellon, 2007.
- JUDITH KLEIN-SEETHARAMAN, Visiting Researcher Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2001.
- KENNETH KOEDINGER, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991.
- DAVID KOSBIE, Assistant Teaching Professor M.S., Carnegie Mellon University; Carnegie Mellon, 2007.
- IOANNIS KOUTIS, Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008.
- ROBERT KRAUT, Herbert A Simon Professor Ph.D., Yale University; Carnegie Mellon, 1993.
- JOHN LAFFERTY, Professor Ph.D., Princeton University; Carnegie Mellon, 1994.
- CHRISTOPHER LANGMEAD, Associate Professor Ph.D., Dartmouth University; Carnegie Mellon, 2004.
- ANTHONY LATTANZE, Associate Teaching Professor M.S., Carnegie Mellon University; Carnegie Mellon, 1999.
- ALON LAVIE, Associate Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996.
- CHRISTIAN LEBIERE, Research Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999.
- PETER LEE, Professor Ph.D., University Of Michigan; Carnegie Mellon, 1987.
- TAI-SING LEE, Associate Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1996.
- LORRAINE LEVIN, Associate Research Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1989.
- YANXI LIU, Associate Research Professor Ph.D., University Of Massachusetts; Carnegie Mellon, 1996.
- JULIO LOPEZ, Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008.
- SIMON LUCEY, Assistant Research Professor Ph.D., University of Southern Queensland; Carnegie Mellon, 2002.
- BRUCE MAGGS, Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1994.
- JENNIFER MANKOFF, Associate Professor Ph.D., Georgia Institute Of Technology; Carnegie Mellon, 2004.
- MATTHEW MASON, Professor and Director, Robotics Institute Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1982.
- NOBORU MATSUDA, Systems Scientist Ph.D., University of Pittsburgh; Carnegie Mellon, 2004.
- ROY MAXION, Research Professor Ph.D., University Of Colorado; Carnegie Mellon, 1984.
- BRUCE MCLAREN, Senior Systems Scientist Ph.D., University Of Pittsburgh; Carnegie Mellon, 2003.
- FLORIAN METZE, Assistant Research Professor Ph.D., Universität Karlsruhe; Carnegie Mellon, 2005.
- GARY MILLER, Professor Ph.D., University Of California; Carnegie Mellon, 1988.
- EDUARDO MIRANDA, Associate Teaching Professor M.S./M.Eng., University of Linköping/University of Ottawa; .
- TERUKO MITAMURA, Research Professor Ph.D., University Of Pittsburgh; Carnegie Mellon, 1990.
- TOM MITCHELL, Fredkin Professor and Director, Machine Learning Department Ph.D., Machine Learning Department Head; Carnegie Mellon, 1986.
- ALAN MONTGOMERY, Associate Professor of Marketing Ph.D., University Of Chicago; Carnegie Mellon, 1999.
- ANDREW MOORE, Professor Ph.D., University Of Cambridge; Carnegie Mellon, 1993.
- JAMES MORRIS, Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1982.
- JACK MOSTOW, Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992.
- TODD MOWRY, Professor Ph.D., Stanford University; Carnegie Mellon, 1997.
- ROBERT MURPHY, Professor Ph.D., California Institute Of Technology; Carnegie Mellon, 1983.
- BRAD MYERS, Professor Ph.D., University Of Toronto; Carnegie Mellon, 1987.
- PRIYA NARASIMHAN, Assistant Professor Ph.D., University Of California; Carnegie Mellon, 2001.
- SRINIVASA NARASIMHAN, Associate Professor Ph.D., Columbia University; Carnegie Mellon, 2004.
- CHRISTINE NEUWIRTH, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983.
- ILLAH NOURBAKSH, Associate 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, Assistant 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.
- NANCY POLLARD, Associate Professor Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2002.
- 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.
- JAMES ROBERTS, Teaching Professor M.S., Carnegie Mellon University; Carnegie Mellon, 1997.
- DAVID ROOT, Associate Teaching Professor M.P.M., Carnegie Mellon University; Carnegie Mellon, 2002.
- CAROLYN ROSE, Assistant Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003.
- RONALD ROSENFELD, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995.
- MANUEL ROSSO-LLOPART, Associate Teaching Professor M.S., Software Engineering, Carnegie Mellon University; Carnegie Mellon, 2000.
- 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, Principal Systems Scientist Ph.D., Carnegie Mellon University; Carnegie Mellon, 1980.
- PAUL RYBSKI, 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.
- 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, Associate 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.
- YASER SHEIKH, Assistant Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008.
- MEL SIEGEL, Associate Research Professor Ph.D., University of Colorado; Carnegie Mellon, 1982.
- DANIEL SIEWIOREK, Professor Ph.D., Stanford University; Carnegie Mellon, 1972.
- SANJIV SINGH, Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994.
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- LATANYA SWEENEY, Distinguished Career Professor Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1998.
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- HOWARD WACTLAR, Alumni Research Professor of Computer Science M.S., University of Maryland; Carnegie Mellon, 1967.
- ALEXANDER WAIBEL, Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988.
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- WILLIAM WHITTAKER, Fredkin Research Professor Ph.D., Carnegie Mellon University; Carnegie Mellon, 1973.
- JEANNETTE WING, President's Professor and Head, Computer Science Department Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985.
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YIMING YANG, Professor Ph.D., Kyoto University; Carnegie Mellon, 1996.

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JOHN ZIMMERMAN, Associate Professor M.Des., Des., Carnegie Mellon University; Carnegie Mellon, 2002.

Tepper School of Business

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Tepper School of Business

Kenneth B. Dunn, Dean
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Undergraduate Office: Tepper 139
www.tepper.cmu.edu

<http://www.tepper.cmu.edu>

Founded in 1949, the Tepper School of Business at Carnegie Mellon is a pioneer in the field of management science and analytical decision-making. The School's notable contributions to the intellectual community include seven 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, graduate 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. The business program provides core coursework in finance, production/operations, marketing, strategy, technology, entrepreneurship. 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 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 continuing 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.

Primary Teaching and Research Areas

- Accounting
- Economics
- Entrepreneurship
- Finance
- Information Systems
- International Business
- Marketing
- Manufacturing and Operations Management
- Operations Research
- Organizational Behavior and Theory
- Statistics
- Strategy

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:

- Carnegie Bosch Institute for Applied Studies in International Management

- Carnegie Mellon Electricity Industry Center
- Center for Behavioral Decision Research
- Center for Excellence in Communication and Leadership
- Center for Financial Markets
- Center for the Interdisciplinary Research on Teams
- Center for International Corporate Responsibility
- Center for the Management of Technology
- Center for Organizational Learning, Innovation and Performance
- Donald H. Jones Center for Entrepreneurship
- The Gailliot Center for Public Policy
- Green Design Institute

Academic Programs

Undergraduate Degrees Offered

The Tepper School of Business offers the following major, additional major, dual, and minor degrees:

- B.S. in Business Administration
- B.A. in Economics
- B.S. in Economics
- B.S. in Economics and Mathematical Sciences
- B.S. in Economics and Statistics
- Additional Major in Business Administration
- Additional Major in Economics
- Minor in Business Administration
- Minor in Economics

Acceptance into the additional major, dual, and minor degree programs is at the discretion of the Undergraduate Program Offices.

Minors, Additional Majors, and Dual Degrees

As a Tepper School undergraduate student, you can pursue additional majors and minors to complement your primary degree, 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 list.

Accelerated Masters Program

All Carnegie Mellon undergraduates with outstanding academic performance are eligible to apply to the Tepper School of Business accelerated MBA program. Students who are accepted bypass their senior year as undergraduates and earn both their bachelors 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 of Health Care and Policy Management, Masters of Public Policy and Management and Masters of Information Systems) offered by the H. J. Heinz III College. Students interested in the Heinz 3-2 program should read the Heinz catalog, available from the Masters Admissions Office. They should also talk with their individual academic advisors concerning completion of their undergraduate requirements.

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 in Tepper School of Business

Both the Undergraduate Economics Program and the Undergraduate Business Administration Program offer qualified students the opportunity to participate in an honors degree program. See each program's section of the catalog for more details.

Academic Standards

Grading Practices

Undergraduate grading regulations are detailed in the University Policies section of the catalog.

Tepper School of Business Dean's Honor List

Each semester, Tepper School of Business 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 3.50 while completing at least 36 factorable units and earning no incomplete grades.

Graduation Requirements

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. 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 Tepper School of Business faculty.

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.

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; Executive 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 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; 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, Assistant 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, John R. Thorne Chair of Entrepreneurship; Associate Teaching Professor of Entrepreneurship; Director, Donald H. Jones Center for 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. CORNUEJOLS, IBM University Professor of Operations Research Ph.D., Cornell University; Carnegie Mellon, 1978.

W. ROBERT DALTON, Associate Teaching Professor of Economics, Emeritus Ph.D., University of Missouri; Carnegie Mellon, 1985.

ROBERT M. DAMMON, Associate Dean, Education; Professor of Financial Economics Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 1984.

TIMOTHY P. DERDINGER, 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.

S. THOMAS EMERSON, David T. and Lindsay J. Morgenthaler Professor of Entrepreneurship 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.

GEORGE-LEVI GAYLE, Assistant Professor of Economics and Strategy Ph.D., University of Pittsburgh; Carnegie Mellon, 2003.

ANISHA GHOSH, Assistant Professor of Finance Ph.D., London School of Economics; Carnegie Mellon, 2009.

JONATHAN C. GLOVER, Professor of Accounting; Head, Ph.D. Program Ph.D., The Ohio State University; Carnegie Mellon, 1992.

LIMOR GOLAN, Associate Professor of Economics Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002.

MARVIN GOODFRIEND, Professor of Economics; Chairman, The Henry J. Gailliot Center for Public Policy Ph.D., Brown University; Carnegie Mellon, 2005.

PAUL S. GOODMAN, Richard M. Cyert Professorship and Professor of Organizational Psychology; Director, Institute for Strategic Development; Co-Director, Center for the Management of Technology Ph.D., Cornell University; Carnegie Mellon, 1972.

RICHARD C. GREEN, 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; Assistant 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 RYOHEI 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 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; Carnegie Mellon, 1984.

YUJI IJIRI, R. M. Trueblood University Professor of Accounting and Economics Ph.D., Carnegie Mellon University; Carnegie Mellon, 1967.

- KINSHUK JERATH, 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.
- SUNDER KEKRE, Bosch Professor of Operations Management Ph.D., University of Rochester; Carnegie Mellon, 1984.
- ONUR KESTEN, Assistant Professor of Economics Ph.D., University of Rochester; Carnegie Mellon, 2006.
- SHAM KEKRE, Associate Teaching Professor of Production and Operations Management - Carnegie Mellon University-Qatar Ph.D., University of Rochester; Carnegie Mellon, 2006.
- CLAUDIA A. KIRKPATRICK, Associate Teaching Professor of Business Management Communication, Emerita D.A., Carnegie Mellon University; Carnegie Mellon, 1982.
- STEVEN KLEPPER, Arthur Arton Hamerschlag 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 KRACKHARDT, 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.
- FINN KYDLAND, The Richard P. Simmons Distinguished Professorship; University Professor of Economics; Nobel Laureate (2004) Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977.
- DAVID L. LAMONT, Associate Teaching Professor; Director, Management Games M.S.I.A., Carnegie Mellon University; Carnegie Mellon, 1984.
- LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics and University Professor; Director, Green Design Institute; Co-Director, Carnegie Mellon Electricity Industry Center Ph.D., Harvard University; Carnegie Mellon, 1963.
- 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.
- FRANCOIS MARGOT, Associate Professor of Operations Research Ph.D., Ecole Polytechnique Fédérale de Lausanne, Switzerland; Carnegie Mellon, 2003.
- JOHN H. MATHER, Executive Director, Masters Programs; Teaching Professor of Marketing Ph.D., University of Arizona; Carnegie Mellon, 1992.
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- ALLAN H. MELTZER, The Allan H. Meltzer University Professor of Political Economy Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957.
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- 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.
- LIN NAN, Assistant Professor of Accounting Ph.D., University of Florida; Carnegie Mellon, 2004.
- JOHN R. O'BRIEN, Associate Professor of Accounting and Experimental Economics Ph.D., University of Minnesota; Carnegie Mellon, 1984.
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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; Carnegie Mellon, 2008.

MEHMET BUMIN YENMEZ, Assistant Professor of Economics Ph.D., Stanford University; Carnegie Mellon, 2010 (on leave AY 2010-2011).

SEVIN YELTEKIN, Associate Professor of Economics Ph.D., Stanford University; Carnegie Mellon, 2005.

RICHARD O. YOUNG, Associate Teaching Professor of Business Management Communication Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985.

Visiting Faculty

ROBERT C. BLATTBERG, Timothy W. McQuire Distinguished Service Professor of Marketing; Executive Director, Center for Marketing Technology and Information Ph.D., Carnegie Mellon University; Carnegie Mellon, 2008.

JIN-WAN CHO, Visiting Associate Professor of Finance Ph.D., Carnegie Mellon University; Carnegie Mellon, 2010.

CARLOS CORONA, Visiting Assistant Professor of Accounting Ph.D., Stanford University; Carnegie Mellon, 2010.

ANNELIES DEUSS, Visiting Assistant Professor of Economics Ph.D., Cornell University; Carnegie Mellon, 2010.

ALBERT E. MANNES, Visiting Assistant Professor of Organizational Behavior and Theory Ph.D., Duke University; Carnegie Mellon, 2009.

NACHIKETA SAHOO, Visiting Assistant Professor in Information Systems Ph.D., Carnegie Mellon University; Carnegie Mellon, 2009.

JACK DOUGLAS STECHER, Visiting Assistant Professor of Accounting Ph.D., University of Minnesota; Carnegie Mellon, 2008.

ANJANA SUSARLA, Visiting Assistant Professor in Information Systems Ph.D., University of Texas at Austin; Carnegie Mellon, 2010.

Adjunct Faculty

ROBERT M. ATKINSON, II, Adjunct Professor of Marketing Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002.

DIANA BLOCK, Adjunct Professor of Business Management Communication M.B.A., Carnegie Mellon University; Carnegie Mellon, 2010.

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.

LLOYD CORDER, Adjunct Professor of Marketing Ph.D., University of Pittsburgh; Carnegie Mellon, 2000.

ROBERT F. CULBERTSON, III, Adjunct Professor of Entrepreneurship M.S.I.A. and M.S. in Engineering, Carnegie Mellon University; Carnegie Mellon, 1999.

CHRIS CYNKAR, Adjunct Professor of Entrepreneurship M.S.I.A., Carnegie Mellon University; Carnegie Mellon, 2008.

L. FRANK DEMMLER, Adjunct Professor of Entrepreneurship M.B.A., University of California at Los Angeles; Carnegie Mellon, 2002.

ROB DILLON, Adjunct Professor of Graphic Media Management B.A., University of Pittsburgh; Carnegie Mellon, 2001.

CLIFFORD T. EARLY, Adjunct Professor of Law J.D., University of Pittsburgh; Carnegie Mellon, 2000.

CAROL B. GOLDBURG, Director, Undergraduate Economics Program; Adjunct Professor of Economics Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005.

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.

ROBERT E. KELLEY, Adjunct Professor of Organizational Behavior and Theory Ph.D., Colorado State University; Carnegie Mellon, 1981.

NANCY S. KOERBEL, Adjunct Professor of Business Management Communication J.D., Duquesne University; M.F.A., The Warren Wilson College; Carnegie Mellon, 2007.

JOHN R. LANKFORD, Adjunct Professor of Marketing; Executive Director, Executive Education M.B.A., University of Michigan; Carnegie Mellon, 1998.

DAVID S. MAWHINNEY, Adjunct Professor of Entrepreneurship M.B.A., Carnegie Mellon University; Carnegie Mellon, 2010.

DAVID RAMIREZ, Adjunct Professor of Business Management M.B.A., Carnegie Mellon University; Carnegie Mellon, 2007.

NORMAN ROBERTSON, Adjunct Professor of Economics B.Sc., University of London; Carnegie Mellon, 1985.

PETER J. ROMAN, Adjunct Professor of Marketing B.S., Providence College; Carnegie Mellon, 2002.

FREDERICK H. RUETER, Adjunct Professor of Economics Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988.

JOEL STERN, Distinguished Adjunct Professor of Finance M.B.A., University of Chicago; Carnegie Mellon, 1996.

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 advisor 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
70-332	Business, Society and Ethics	9
70-340	Business Communications	9
70-345	Business Presentations	9
70-371	Production/Operations Management	9
70-381	Marketing I	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
73-150	Intermediate Microeconomics	9
73-200	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 and Approximation ⁽¹⁾	9
21-257	Models and Methods for Optimization ⁽²⁾	9
70-207	Probability and Statistics for Business Applications	9
70-208	Regression Analysis	9
99-101 /102	Computing @ Carnegie Mellon	3

¹ or 21-259 Calculus in Three Dimensions

² or 21-292 Operations Research I

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 political science. Students should consult the 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
		<hr/> 49

Spring		Units
21-256	Multivariate Analysis and Approximation	9
73-150	Intermediate Microeconomics	9
15-110	Principles of Computing	10
79-104	Global Histories	9
xx-xxx	Breadth course	9
		<hr/> 46

Sophomore Year

Fall		Units
21-257	Models and Methods for Optimization ⁽³⁾⁽⁶⁾	9
70-122	Introduction to Accounting	9
70-207	Probability and Statistics for Business Applications	9
73-200	Intermediate Macroeconomics	9
xx-xxx	Breadth course	9
		<hr/> 45

Spring		Units
70-208	Regression Analysis	9
70-311	Organizational Behavior	9
70-340	Business Communications	9
xx-xxx	Minor Course	9
xx-xxx	Breadth course	9
		<hr/> 45

³ or 21-292 Operations Research I, offered in spring semesters only

Junior Year

Fall		Units
70-371	Production/Operations Management	9
70-381	Marketing I	9
70-391	Finance	9
70-451	Management Information Systems	9
xx-xxx	Breadth Course	9
		<hr/> 45

Spring		Units
70-332	Business, Society and Ethics	9
70-345	Business Presentations	9
70-451	Management Information Systems	9
70-xxx	Track Course	9
70-xxx	Track Course	9
		<hr/> 45

Senior Year

Fall		Units
70-xxx	Track Course	9
70-xxx	Track Course	9
xx-xxx	Minor Course	9
xx-xxx	Minor Course	9
70-201	Professional and Service Projects	9
		<hr/> 45

Spring		Units
70-401	Management Game	12
70-xxx	Track Course	9
70-xxx	Track Course	9
xx-xxx	Minor Course	9
xx-xxx	Minor Course	9
		<hr/> 48

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

	Units
21-120 Differential and Integral Calculus or 21-111 Calculus I (10 units) and 21-112 Calculus II (10 units)	10
21-256 Multivariate Analysis and Approximation or 21-259 Calculus in Three Dimensions (9 units)	9
21-257 Models and Methods for Optimization or 21-292 Operations Research I (9 units)	9
70-207 Probability and Statistics for Business Applications or 36-201 Statistical Reasoning and Practice (9 units)	9
70-208 Regression Analysis or 36-202 Statistical Methods (9 units)	9
	46

Computing

99-101 /102 Computing @ Carnegie Mellon	3
15-110 Principles of Computing	10

Economics

73-100 Principles of Economics	9
73-150 Intermediate Microeconomics	9
73-200 Intermediate Macroeconomics	9

Business

	Units
70-122 Introduction to Accounting	9
70-311 Organizational Behavior	9
70-332 Business, Society and Ethics	9
70-345 Business Presentations	9
70-371 Production/Operations Management	9
70-381 Marketing I	9
70-391 Finance	9
70-451 Management Information Systems ⁽⁴⁾	9
70-401 Management Game ⁽⁵⁾	12
70-3xx /4xx Electives (2)	18
	84

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 73-100 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):

	Units
73-100 Principles of Economics (required)	9
70-122 Introduction to Accounting	9
70-311 Organizational Behavior	9
70-371 Production/Operations Management	9
70-381 Marketing I (required)	9
70-391 Finance	9
70-342 Managing Across Cultures	9
70-430 International Management	9

70-451 Management Information Systems ⁽⁶⁾	9
70-480 International Marketing	9
70-481 Marketing Research	9
70-483 Advertising and Marketing Communications	9
	108

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.

Some courses have prerequisites that might include specific mathematics or other BA courses. These may be found in the course descriptions and should be discussed with an advisor.

Students may declare the minor at any point after their freshman year by completing the minor declaration form. The form is available online at the Undergraduate Business Administration Website.

Minor in Business Administration (CIT Students Only)

Only students in the Carnegie Institute of Technology are permitted to meet the business administration minor requirements by completing the following selection of courses:

Required:

70-371 Production/Operations Management	9
70-471 Logistics and Supply Chain Management	9
21-257 Models and Methods for Optimization	9
21-292 Operations Research I	9
70-460 Mathematical Models for Consulting	9
70-474 Quality Principles and Techniques	9

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 the spring term 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. 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 an 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, please see the course description for 70-500 or contact an 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.

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
 Stephanie A. Vega, Academic Advisor
 Program Office: Tepper School of Business 139
 E-mail: econprog@andrew.cmu.edu

<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 development of market strategies, the promulgation of regulatory structures, and the 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. Six 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.

At Carnegie Mellon University, the Undergraduate Economics Program is supported by both the Tepper School of Business and the College of Humanities and Social Sciences. Economics majors are considered members of both colleges and enjoy their full support and services.

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 will be able to identify, explain, and use economic concepts, theories, models, and data-analytic techniques.
- Students will acquire a deep knowledge of economics, mathematics, statistics, and computing, providing the foundation for success in graduate studies and careers in the public and private sectors.
- Students will 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 will acquire the investigative skills necessary for conducting original economic research and participating effectively in project teams.
- Students will 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. 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.

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).

For students who major in other academic fields, an additional major program and a minor degree program in Economics are available. This information can be found following the discussions about the major curricula.

The Majors

The four 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.

Firstyear students are not expected to know which degree option they wish to pursue. For this reason, the firstyear curricula are identical. As students become involved in their course work, participate in the extra and cocurricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes evident.

The B.A. in Economics Curriculum and the B.S. in Economics Curriculum are designed to provide students with a solid understanding of economic theory and quantitative economic analysis. The introductory core disciplinary sequences in economic theory and quantitative analysis are identical: both rely on the same knowledge base of calculus and statistics. Where these two degree programs differ is in their emphases of study in the advanced levels. The advanced data analysis component of the B.A. in Economics Curriculum pays additional attention to ordinal data and the study of surveys. The flexibility of the Special Electives requirement allows students the opportunity to study political, historical, cultural, and social institutions. In the advanced levels of the economic theory component of the B.S. in Economics Curriculum, the foundations of modern economics are examined, using mathematically sophisticated models. The capstone of the two degree programs 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.

The B.S. in Economics and Mathematical Sciences Curriculum 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 slots in this program; interested students may apply as early as their sophomore year.

The B.S. in Economics and Statistics Curriculum is a collaborative effort between the Department of Statistics and the Undergraduate Economics Program. It provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. The major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economics issues through the analysis, synthesis, and reporting of data using the advanced empirical research methods of statistics and econometrics.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree in economics by completing all of the requirements for the B.S. in Economics. 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.

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 H&SS Honors Program website.

The 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: participation in the Junior Honors Research Seminar in Economics, 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 Colloquia.

Accelerated Master's Degree Programs

Accelerated Master's Degree programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Heinz College offers four professional accelerated masters degree programs: a Master of Science in Arts Administration, Master of Science of Health Care and Policy Management, Master of Information Systems Management, and Master of Science in Public Policy and Management. The Tepper School of Business offers one accelerated professional degree, a Master in Business Administration. For more details, visit the Accelerated Master's Degree Programs site on the Undergraduate Economics Program website.

Degree Requirements and Sample Schedules

In addition to completing a minimum 360 units and fulfilling both the H&SS General Education requirements and all University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economics 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. It is the responsibilities of the students to ensure 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 corequisite requirements.

B.A. in Economics Curriculum

Mathematics Prerequisites (19 units)

Courses	Units
21-120 Differential and Integral Calculus	10
21-256 Multivariate Analysis and Approximation	9

Programming Requirement (10 Units)

15-110 Principles of Computing	10
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Writing Requirement (9 units)

73-270 Writing for Economists	9
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Economic Theory Requirements (27 units)

73-100 Principles of Economics	9
73-150 Intermediate Microeconomics	9
73-200 Intermediate Macroeconomics	9

Economic History Requirement (9 Units)

73-310 Evolution of Economic Ideas and Analysis	9
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Quantitative Analysis Requirements (54 Units)

36-201 Statistical Reasoning and Practice	9
36-202 Statistical Methods	9
36-225 Introduction to Probability Theory	9
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9
36-303 Sampling, Survey and Society	9

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 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.

Course List

Representative List of "Special Elective" Courses	Units
79-246 Industrial America	9
79-300 History of Public Policy in the United States	9
79-335 Drug Use and Drug Policy	9
79-375 China's Environmental Crisis	9
79-386 Entrepreneurs in Africa, Past, Present and Future	9
80-130 Introduction to Ethics	9
80-235 Political Philosophy	9
80-305 Rational Choice	9
80-321 Causation, Law, and Social Policy	9
88-387 Social Norms and Economics	9
88-412 Economics of Global Warming	9

A complete and updated list can be found on the B.A. in Economics website.

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)

	Units
73-497 Senior Project	9
or 73-500 Tepper College Honors Thesis I <i>and</i> 73-501 Tepper College Honors Thesis II	
or 66-501 H&SS Senior Honors Thesis I (9 units) <i>and</i> 66-502 H&SS Senior Honors Thesis II (9 units)	

Sample Schedule for B.A. in Economics**First Year**

	Units
Fall Term	
21-120 Differential and Integral Calculus	10
36-201 Statistical Reasoning and Practice	9
99-101 Computing @ Carnegie Mellon	3
73-100 Principles of Economics	9
76-101 Interpretation and Argument	9
xx-xxx Freshman Seminar	9
	49

	Units
Spring Term	
15-110 Principles of Computing	10
36-202 Statistical Methods	9
21-256 Multivariate Analysis and Approximation	9
73-150 Intermediate Microeconomics	9
79-104 Global Histories	9
	46

Second Year

	Units
Fall Term	
36-225 Introduction to Probability Theory	9
73-200 Intermediate Macroeconomics	9
xx-xxx "Special Elective"	9
xx-xxx Open	9
xx-xxx Open	9
	45

	Units
Spring Term	
36-226 Introduction to Probability and Statistics II	9
73-270 Writing for Economists	9
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
	45

Third Year

	Units
Fall Term	
73-261 Econometrics	9
73-310 Evolution of Economic Ideas and Analysis	9
xx-xxx "Special Electives"	9
xx-xxx Open	9
xx-xxx Open	9
	45

	Units
Spring Term	
36-303 Sampling, Survey and Society	9
xx-xxx Advanced Economics Elective	9
xx-xxx "Special Elective"	9
xx-xxx Open	9
xx-xxx Open	9
	45

Fourth Year

73-497 Senior Project	9
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9

	Units
Spring Term	
xx-xxx Advanced Economics Elective	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9
xx-xxx Open	9
	45

B.S. in Economics Curriculum**Mathematics Requirements (29 Units)**

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-259 Calculus in Three Dimensions	9
or 21-256 Multivariate Analysis and Approximation (9 units)	

Programming Requirement (10 Units)

15-110 Principles of Computing	10
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Quantitative Analysis Requirements (27 Units)

36-225 Introduction to Probability Theory	9
or 36-217 Probability Theory and Random Processes (9 units)	
or 21-325 Probability (9 units)	
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9

Writing Requirement (9 Units)

73-270 Writing for Economists	9
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Economic Theory Requirements (39 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

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)

		Spring Term	Units
73-497 Senior Project	9	xx-xxx Advanced Economics Elective	9
or 73-500 Tepper College Honors Thesis I and		xx-xxx Open	9
73-501 Tepper College Honors Thesis II		xx-xxx Open	9
or 66-501 H&SS Senior Honors Thesis I (9 units) and		xx-xxx Open	9
66-502 H&SS Senior Honors Thesis II (9 units)		xx-xxx Open	9
			45

Sample Course Schedule for the B.S. in Economics

First Year

Fall Term		Units	
21-120 Differential and Integral Calculus	10		
36-201 Statistical Reasoning and Practice	9		
73-100 Principles of Economics	9		
76-101 Interpretation and Argument	9		
99-101 Computing @ Carnegie Mellon	3		
xx-xxx Freshman Seminar	9		
			49

Spring Term		Units	
15-110 Principles of Computing	10		
21-259 Calculus in Three Dimensions	9		
36-202 Statistical Methods	9		
73-150 Intermediate Microeconomics	9		
79-104 Global Histories	9		
			46

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		
xx-xxx Open	9		
xx-xxx Open	9		
			46

Spring Term		Units	
73-252 Advanced Microeconomic Theory	6		
73-253 Advanced Macroeconomic Theory	6		
73-270 Writing for Economists	9		
xx-xxx Advanced Economics Elective	9		
xx-xxx Open	9		
xx-xxx Open	9		
			48

Third Year

Fall Term		Units	
73-261 Econometrics	9		
xx-xxx Advanced Economics Elective	9		
xx-xxx Open	9		
xx-xxx Open	9		
xx-xxx Open	9		
			45

Fourth Year

Fall Term		Units	
73-261 Econometrics	9		
xx-xxx Advanced Economics Elective	9		
xx-xxx Open	9		
xx-xxx Open	9		
xx-xxx Open	9		
			45

Spring Term		Units	
xx-xxx Advanced Economics Elective	9		
xx-xxx Open	9		
xx-xxx Open	9		
xx-xxx Open	9		
xx-xxx Open	9		
			45

B.S. in Economics and Mathematical Sciences Curriculum

Economic Theory Requirements (39 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		

Quantitative Analysis Requirements (36 Units)

36-225 Introduction to Probability Theory		9	
or 36-217 Probability Theory and Random Processes (9 units)			
or 21-325 Probability (9 units)			
36-226 Introduction to Probability and Statistics II	9		
73-261 Econometrics	9		
36-401 Modern Regression	9		

Mathematical Sciences Requirements (92 Units)

21-120 Differential and Integral Calculus		10	
21-122 Integration, Differential Equations and Approximation	10		
21-127 Concepts of Mathematics	9		
21-228 Discrete Mathematics	9		
21-241 Matrix Algebra	9		
21-259 Calculus in Three Dimensions	9		
21-260 Differential Equations	9		
21-355 Principles of Real Analysis I	9		
21-356 Principles of Real Analysis II	9		
21-373 Algebraic Structures	9		

Programming Requirement (9 Units)

15-110 Principles of Computing		10	
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Writing Requirement (9 Units)

73-270	Writing for Economists	9
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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 pre-requisite. 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
21-357	Sequences and Series of Functions	9
21-365	Projects in Applied Mathematics	9
21-366	Topics in Applied Mathematics	9
21-371	Functions of a Complex Variable	9
21-374	Field Theory	9
21-441	Number Theory	9
21-460	Topology	9
21-484	Graph Theory	9
21-499	Undergraduate Research Topic	9

Note: Only one of the following three courses may count towards the required Mathematical Sciences Depth Electives: 21-365, 21-366, or 21-499.

Sample Course Schedule for the B.S. in Economics and Mathematical Sciences**First Year**

Fall Term		Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning and Practice	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
		<hr/> 49

Spring Term		Units
79-104	Global Histories	9
15-110	Principles of Computing	10
73-150	Intermediate Microeconomics	9
21-259	Calculus in Three Dimensions	9
xx-xxx	Open	9
		<hr/> 46

Second Year

Fall Term		Units
21-127	Concepts of Mathematics	9
73-200	Intermediate Macroeconomics	9
36-225	Introduction to Probability Theory	9
21-259	Calculus in Three Dimensions	9
xx-xxx	Open	9

Spring Term		Units
36-226	Introduction to Probability and Statistics II	9
21-241	Matrix Algebra	9
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
xx-xxx	Advanced Economics Elective	9
xx-xxx	Open	9
		<hr/> 48

Third Year

Fall Term		Units
21-260	Differential Equations	9
73-261	Econometrics	9
73-270	Writing for Economists	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Mathematics Depth Elective	9
		<hr/> 45

Spring Term		Units
21-355	Principles of Real Analysis I	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	Mathematics Depth Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 45

Fourth Year

Fall Term		Units
21-228	Discrete Mathematics	9
21-356	Principles of Real Analysis II	9
36-401	Modern Regression	9
73-497	Senior Project	9
xx-xxx	Open	9
		<hr/> 45

Spring Term		Units
21-373	Algebraic Structures	9
xx-xxx	Mathematics Depth Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 45

B.S. in Economics and Statistics Curriculum**Mathematics Requirements (38 Units)**

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-259	Calculus in Three Dimensions	9
	or 21-256 Multivariate Analysis and Approximation (9 units)	
21-241	Matrix Algebra	9

Programming Requirement (9 Units)

15-110	Principles of Computing	10
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Writing Requirement (9 Units)

73-270	Writing for Economists	9
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Disciplinary Core - Economics

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

36-202	Statistical Methods	9
	or 36-309 Experimental Design for Behavioral and Social Sciences (9 units)	
	or 70-208 Regression Analysis (9 units)	
36-225	Introduction to Probability Theory	9
	or 36-217 Probability Theory and Random Processes (9 units)	
	or 21-325 Probability (9 units)	
36-226	Introduction to Probability and Statistics II	9
36-401	Modern Regression	9
36-402	Advanced Data Analysis	9

Advanced Economics Electives (18 Units)

Students must take two 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.

Statistical Electives (18 Units)

Students must take two statistics elective courses which are numbered 36-300 and higher.

Sample Course Schedule for the B.S. in Economics and Statistics

First Year

Fall Term		Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning and Practice	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
		<hr/> 49

Spring Term		Units
15-110	Principles of Computing	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Intermediate Microeconomics	9
79-104	Global Histories	9
		<hr/> 46

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
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 46

Spring Term		Units
21-241	Matrix Algebra	9
36-226	Introduction to Probability and Statistics II	9
73-252	Advanced Microeconomic Theory	6
73-253	Advanced Macroeconomic Theory	6
73-270	Writing for Economists	9
xx-xxx	Open	9
		<hr/> 48

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
		<hr/> 45

Spring Term		Units
36-402	Advanced Data Analysis	9
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 45

Fourth Year

Fall Term		Units
xx-xxx	Statistics Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 45

Spring Term		Units
xx-xxx	Advanced Economic Elective	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
xx-xxx	Open	9
		<hr/> 45

Additional Major in Economics Curriculum

The requirements for the Additional Major in Economics are the same as those for the B.S. in Economics, except that the H&SS general education requirements are waived. In order to avoid double counting issues, students are encouraged to meet with an economics advisor.

Minor in Economics

The requirements for a Minor in Economics consist of mathematics requirements, computing requirements, probability and statistics requirements, and economics courses listed below. In order to avoid double counting issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements (19 Units)

	Units
21-120 Differential and Integral Calculus	10
21-256 Multivariate Analysis and Approximation	9

Computing Requirements (10 Units)

	Units
15-110 Principles of Computing	10

Economic Theory Requirements (27 Units)

73-100 Principles of Economics	9
73-150 Intermediate Microeconomics	9
73-200 Intermediate Macroeconomics	9

Quantitative Analysis Requirements (27 Units)

	Units
36-225 Introduction to Probability Theory or 21-325 Probability (9 units) or 36-217 Probability Theory and Random Processes (9 units)	9
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9

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.

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. DERDINGER, 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.

GEORGE-LEVI GAYLE, Assistant Professor of Economics and Strategy Ph.D., University of Pittsburgh; Carnegie Mellon, 2003.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy, H. J. Heinz III College Ph.D., Northwestern University; Carnegie Mellon, 1995.

LIMOR GOLAN, Associate Professor of Economics Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002.

MARVIN GOODFRIEND, Professor of Economics; Chairman, The Henry J. Gailliot 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. 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.

ONUR KESTEN, Assistant Professor of Economics Ph.D., University of Rochester; Carnegie Mellon, 2005.

STEVEN KLEPPER, Arthur Arton Hamerschlag 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.

FINN KYDLAND, The Richard P. Simons Distinguished Professorship; University Professor of Economics; Nobel Laureate (2004) Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977.

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.

BENNETT T. 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.

ROBERT A. MILLER, Professor of Economics and Strategy Ph.D., University of Chicago; Carnegie Mellon, 1982.

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. SEPPI, 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.

336 Undergraduate Economics Program

MEHMET B. YENMEZ, Assistant Professor of Economics Ph.D., Stanford University; Carnegie Mellon, 2010 (On leave 2010-2011AY).

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.

Carnegie Mellon University in Qatar

Carnegie Mellon University in Qatar

G. Richard Tucker, Dean of Carnegie Mellon University in Qatar
John G. Robertson, Assistant Dean for Academic Affairs
<http://www.qatar.cmu.edu/>

Carnegie Mellon University in Qatar is Carnegie Mellon's first undergraduate branch campus. The campus opened in 2004 as part of a collaborative effort with the Qatar Foundation to bring outstanding American education programs to the Middle East. The University shares their commitment to maintain the same quality of instruction and standard of student performance demanded on the main campus.

The campus offers three academic programs, Business Administration, Computer Science, and Information Systems. To learn more about them, see their respective main campus college sections in the Undergraduate Catalog. The purpose of this section is to describe the policies of the Qatar campus that are independent from those of the Pittsburgh campus and outline procedures that are common to students in all programs in Qatar.

Degree Offerings

Carnegie Mellon in Qatar offers three undergraduate degrees:

- Bachelor of Science in Business Administration
- Bachelor of Science in Computer Science
- Bachelor of Science in Information Systems

Policy Statement

Carnegie Mellon in Qatar complies with common University policies unless otherwise noted. The curriculum requirements for the Business Administration, Computer Science, and Information Systems majors are identical to those of the Tepper School of Business, the School of Computer Science and the College of Humanities and Social Sciences.

Academic Standards and Actions

The same academic standards and actions apply to all programs in Qatar as at the main 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 QPA of 3.75 or higher (while taking at least 36 factorable units and receiving no incompletes) or earn a semester QPA of 3.50 or higher (while taking at least 45 factorable units and receiving no incompletes).

Other Actions

Students are subject to academic actions if they fail to make minimal progress toward their degree. Minimal progress is achieving a semester QPA of at least 2.00. 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 QPA.

The criteria for first-year students are different — they are not subject to academic actions unless their semester QPA is below 1.75.

Probation

Probation occurs when a student's semester record fails to meet the minimal standards listed above. Students remove themselves from probation if they complete at least 36 factorable units and raise their cumulative QP above 2.00 (minus the first year if that is higher). 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 minimal standards stated above at the end of the probation semester, the school will suspend them. 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 return from suspension on probation.

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. 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

Course Overloads

A Qatar Campus 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. If a student carrying an overload is in severe academic difficulty during the semester, the Assistant Dean for Academic Affairs may withdraw the student from the overload course.

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

The Qatar campus 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 Qatar Campus 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) may not drop below 36 units after the 10th regularly scheduled day of classes.

Non-Carnegie Mellon Courses

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 on-line.

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.

after the first year. Students must also meet all University residence requirements and meet all financial obligations to the University before receiving a degree.

A student may seek permission to modify graduation requirements by petition to the Assistant Dean for Academic Affairs.

Transferring

Between majors in Qatar

Students may transfer between majors on the Qatar campus 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.

Within majors between Qatar and Pittsburgh

Qatar Campus and Pittsburgh campus 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. CS students must have completed 15-211, BA students 21-256 , and IS students 15-121 . 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 main campus into a different major do so through 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

Qatar campus and Pittsburgh campus students may study on the opposite 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.

College Honors

Students entering their senior year may undertake an Honors Thesis if they meet their major college's eligibility requirements. Any interested students should contact the Assistant dean for Academic Affairs for details.

Graduation Requirements

In order to graduate with a Bachelor of Science in Business Administration, Computer Science, or Information Systems students must meet all requirements specified for that program with a cumulative quality point average of at least 2.00 for all courses taken

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Course Descriptions

Note on Course Numbers

Each Carnegie Mellon course number begins with a two-digit prefix which designates the department offering the course (76-xxx courses are offered by the Department of English, etc.). The first digit after the prefix indicates the class level: xx-1xx courses are freshmen-level, xx-2xx courses are sophomore level, etc. xx-6xx courses may be either undergraduate senior-level or graduate-level, depending on the department. xx-7xx courses and higher are graduate-level. Please consult the Schedule of Classes each semester for course offerings and for any necessary pre-requisites or co-requisites.

Department of Computational Biology

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.

Department of Biological Sciences

03-050 Study Abroad

Fall

03-051 Study Abroad

Spring

03-101 Biological Sciences First Year Seminars

Fall and 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.

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

Fall and Spring: 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.

Prerequisites: 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 03-230. 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

Intermittent: 9 units

This course surveys the pattern and process of biological evolution. Major topics include: historical recognition of evolutionary pattern (biological diversity in geological time); foundation theory of evolutionary process; relationships of the major domains/kingdoms of life; early Earth and prebiotic evolution; origin of nucleic acids and self-replication; origin of prokaryotes; endosymbiosis and origin of the eukaryotic cell; origin and evolution of protostians, fungi, plants, and animals; modern theory of evolutionary process, including microevolution, speciation, and macroevolution; relationship of evolution and systematics; molecular approaches to the study of evolution and the construction of phylogenies.

Prerequisites: 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 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. Enrollment is limited to first year students in MCS. Special permission required.

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.

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 42-101 Introduction to Biomedical Engineering and expose students to four areas of biomedical engineering: bioimaging, 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. NOT FOR MCS STUDENTS. Pre-medical CIT students may substitute this course for 03-124 Modern Biology Laboratory. Students given preference are Sophomore Chemical Engineers and Materials Science & Engineering majors. Special permission required.

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.

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. Prerequisites: 03-121
Corequisite: 09-217

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, energy 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: 06-221, 09-106

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 interaction. 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)

03-301 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

03-310 Introduction to Computational Biology

Spring: 12 units

This course covers the application of computers to solve problems in biology and medicine. Since computers are increasingly used in biological research, the course is valuable for all biological sciences majors and interested students from other departments. It is intended for students without computer programming experience (students with a desire to apply programming methods to these problems should take the more advanced course 03-511, Computational Molecular Biology and Genomics). 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 consists primarily of homework assignments making use of software packages for these applications. Students may not get credit for 03-310 and 03-510, 03-311 or 03-312.

Prerequisites: 03-121

03-311 Introduction to Computational Molecular Biology

Spring: 6 units

This course presents both the theoretical underpinnings of computational methods used in modern molecular biology and practical training in using these methods and the data resources to which they can be applied. It is intended for students without computer programming experience. Topics included are biological sequencing and databases, sequence searching and alignment, protein structure, whole genome resources, genetic variations and their relationship to phenotype, gene and protein expression, and biological networks and pathways. Course work consists primarily of homework assignments making use of online resources for these applications. Students may not get credit for both 03-310 and 03-311 or 03-312.

Prerequisites: 03-121

03-312 Introduction to Computational Biological Modeling and Imaging

Spring: 6 units

This course presents both the theoretical underpinnings of computational methods relevant to cell biology and practical training in using these methods and the data resources to which they can be applied. It is intended for students without computer

programming experience. Topics included are bioimage processing and analysis, automated analysis and modeling of microscope images, mathematical methods used for biological modeling, basic computational models of population dynamics, neuronal signaling, biochemical reactions and drug metabolism, and cell simulations. Course work consists primarily of homework assignments making use of online resources for these applications. Students may not get credit for both 03-310 and 03-311 or 03-312.
Prerequisites: 03-121

03-315 Magnetic Resonance Imaging in Neuroscience

Spring: 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.
Prerequisites: 03-121

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. This 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.
Prerequisites: 03-240

03-362 Cellular 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 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.
Prerequisites: 03-121

03-363 Systems 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 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

03-380 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 new and 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 antiviral response 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.

Prerequisites: 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 Introduction to Microbiology

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 antimicrobial 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 Genes and Diseases

All Semesters: 9 units

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 quantitative biology as seen 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 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 and biology, in a uniﬁed perspective.

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 (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.

Prerequisites: 03-330

03-445 Undergraduate Research

Fall and Spring

Students may investigate research problems under the supervision of members of the faculty. 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: (15-211 and 03-510) or 15-451

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 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 15-211

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.

Prerequisites: 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 an essential component of this course. Special permission is required.

Department of Human-Computer Interaction

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. Prerequisites: 15-211

05-320 Social Web

12 units

With the growth of online environments like MySpace, Second Life, World of Warcraft, Flickr, YouTube, Wikipedia, blogs, online support groups, and open source development communities, the web is no longer just about information. It is filled with social networks, multi-player games, and member-contributed content. This course, jointly taught by a computer scientist and a behavioral scientist, will examine how the social web operates, teach students how to build online communities, and help them understand the social impact of spending at least part of their lives online. We will examine what works and what fails to work in these online environments, and will use tools like Ruby on Rails and Drupal to build them. 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 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.

05-395 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 ergonomics. 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. 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.

05-410 Human-Computer Interaction Methods

Fall: 12 units

This course provides an 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). Course is open to undergrads and graduate level non-HCI majors. 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 information devices. The course also 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 perceptual, 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: 12 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, to write a paper 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 prototypes 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: 9 units

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 analyzing human problem solving. They will learn about the Cognitive Tutor technology that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. They will learn about methods for assessing robust learning. 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. <http://www.cs.cmu.edu/~aleven/teaching/fall2008-05832.html>
PREREQUISITES 05-650 or 15-200 or 15-211 or 85-213 or instructor permission. Preferred: 05-410 or a course in AI.
Prerequisites: 15-211 or 85-213 or 85-411

05-499 Special Topic's in HCI

Intermittent

05-499 A: Mapping Braddock (Jill Miller) 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.

05-509 Game Design

Spring: 12 units

05-509 Game Design Spring: 12 units The goal of this course is to prepare students interested in entertainment technology for a career involving design of computer games and other interactive experiences. Students in this course will read and write about game design, and design many games of their own. Do not mistake this for a course in computer game development. This course is focused on the rules and methods of game design, which remain fairly constant regardless of the technology used to develop a game. While technology will play a significant role in our studies, technological

details will not be our focus. Students will study and design games of all sorts: card games, dice games, athletic games, story games, and yes, even video games. How to design games, how to design them well, and how to see your designs to completion will be what students master in this course.

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 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.

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: 05-431, 05-631

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.

Department of Chemical Engineering

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: 09-105, 21-120

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; interconversion 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: 06-100 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. Finally, 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.

Prerequisites: 06-221 and 21-122

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 Engineering Thermodynamics

Fall: 9 units

The objective of this course is to cover principles and solution techniques for phase and chemical equilibria in multicomponent systems. Topics include thermodynamic properties of ideal and non-ideal mixtures; criteria for equilibrium; chemical potential, fugacity and activity coefficients; flash calculations; Gibbs energy minimization; thermodynamics of chemical reactions including equilibrium conversions.

Prerequisites: 06-221

06-322 Junior Chemical Engineering Seminar

Fall: 2 units

This course discusses career choices for chemical engineers, professional practice, including alternate career paths, global industry, and graduate studies. It also emphasizes writing, interview skills, and oral presentations. Safety, environmental and ethical issues are illustrated in projects and via invited lectures.

06-323 Heat and Mass Transfer

Fall: 9 units

This course presents the fundamentals of heat and mass transfer, including steady-state and transient heat conduction and molecular diffusion, convection of heat and mass, and thermal radiation, with application to heat and mass transfer processes. Development of dimensionless quantities for engineering analysis is emphasized.

Prerequisites: 06-262 or 21-260

06-361 Unit Operations of Chemical Engineering

Spring: 9 units

This course comprises many of the standard operations in chemical plants such as gas absorption, heat exchange, distillation and extraction. The design and operation of these devices is emphasized. A project dealing with a novel unit operation is also investigated.

Prerequisites: 06-321 and 06-323

06-362 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.

Prerequisites: 06-262

06-363 Transport Process Laboratory

Spring: 6 units

Develop skills for proposing, designing, planning, implementing, interpreting, and communicating the results of experiments in fluid flow and heat and mass transfer. Oral and written reports are required.

Prerequisites: 06-261 and 06-323

06-400 Senior 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.

06-421 Chemical Process Systems Design

Fall: 12 units

Screening of processing alternatives. Computational strategies for preliminary material and energy balances in large chemical processes. Preliminary sizing of process equipment. Cost estimation, economics, and evaluation for chemical plants. Strategies for synthesizing energy networks and separation sequences. Preliminary design of a large industrial project.

Prerequisites: 06-321

Corequisite: 06-422

06-422 Chemical Reaction Engineering

Fall: 9 units

Fundamental concepts in the kinetic modeling of chemical reactions, the treatment and analysis of rate data. Multiple reactions and reaction mechanisms. Analysis and design of ideal and non-ideal reactor systems. Energy effects and mass transfer in reactor systems. Introductory principles in heterogeneous catalysis.

Prerequisites: 09-347

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 06-362

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.

Prerequisites: 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.

Prerequisites: 06-421
Corequisite: 06-462

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, strategies for 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 physico-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 of the instructor.
Prerequisites: 09-347

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 of the instructor.
Prerequisites: 06-422 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 a testable 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 of 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, bioconversions, 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 of 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

Institute for Software Research

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: 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 indepth 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 able to tailor their assignments to their skills and interests, focusing more on programming or writing papers as they see fit. However, all 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.

Department of Chemistry

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, thermochemistry, transition metal chemistry, chromatography, and protein biochemistry. 1 hr. lec., 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, plastics, 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 in perspective. After achieving 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.

Prerequisites: 09-105 or 09-107

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 tastesweet? 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. For this course high school background in chemistry would help but nothing more advanced is required. Concepts will be discussed on a need to know basis. Students with stronger chemistry backgrounds should enroll in 09-209. 3 hrs. lec. and lab

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.

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 tastesweet? 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 33106) 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 such as carbohydrates, proteins and 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 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, bioorganic 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. Prerequisites: 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 instrumental 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. Prerequisites: 09-106

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: 09-218, 09-220

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 21-123)

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.

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.

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

Corequisite: 09-345

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

09-341 The Art and Science of Color

Intermittent: 9 units

The color of minerals is a property easily noticeable by the expert and the casual viewer alike, and has made minerals attractive to people for millennia. Artists have made use of minerals to create inorganic pigments, which formed the bulk of the artistic palette until the industrial revolution. 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, and often performing the purification and grinding of the minerals

into pigments. With the advent of mass-produced and marketed art materials in the 19th century, the distance between chemist and artist increased until the two worlds have little to do with one another. The class aims to reconnect Chemistry and Art for a study of their common ground, particularly the color of minerals. This color is underscored by inorganic chemistry, which governs the formation and properties of minerals. Students learn about the origin of the color of minerals with focus on colors that originate from electronic transitions and apply knowledge of the electronic structure of transition metal ions to analyze and interpret the color. Students work collaboratively with Art students on laboratory research projects that involve the synthesis, characterization, and use of inorganic pigments. They interact with the scientists of the Hillman Hall of Minerals and Gems of the Carnegie Museum of Natural History and of the Art Conservation Research Center at Carnegie Mellon. Researchers who work at the boundary between art and chemistry will give guest lectures. This is a project course open exclusively to majors in chemistry and art. The course and its projects are designed to expand the expertise of students in both disciplines, while exposing them to the methods, demands and aims of the other. 2 hrs. lec, 3 hrs lab
Prerequisites: 09-348 and 09-221

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 (21-259 or 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)

09-347 Advanced Physical Chemistry

Fall: 12 units

09-347 Advanced Physical Chemistry Fall: 12 units A course of study designed to provide the microscopic basis of concepts encountered in the field of chemical engineering. The properties of macroscopic materials are calculated in terms of the microscopic properties of atoms and molecules. Both classical and quantum approaches are employed. The thermodynamic properties are developed in terms of the chemical potentials of the constituent particles. The transport properties are calculated using molecular dynamics and Brownian dynamics. Classical chemical kinetics is fully developed and applied to complex reactions. Rate constants are calculated for simple reactions in gases and solutions. The course enrollment is limited to chemical engineering majors. 4 hrs. lec.

Prerequisites: (06-151 or 06-221) and (06-155 or 06-262) and (09-105 or 09-107)

09-348 Inorganic Chemistry

Spring: 10 units

The focus of this class is understanding the properties of the elements and of the inorganic compounds. The electronic structure of elements is discussed as the basis for the element's organization in the Periodic Table and for their properties. The systematic chemistry of main group elements and of transition metals is presented. The number of inorganic compounds is extremely large and their properties are extremely diverse. Therefore in this course, the presentation of physical and chemical properties of inorganic compounds is based upon the observation of the trends in the respective properties and the relation between these trends and the place of the elements in the Periodic Table. 3 hrs. lec., 1 hr. rec.

Prerequisites: 09-106

09-401 Undergraduate Seminar V

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.

09-402 Undergraduate Seminar VI

Fall and Spring: 3 units

Students enrolled in this 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. Thoroughness in the use of the chemical literature is emphasized. The use of presentation aids such as PowerPoint is required. 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.

09-435 Independent Study Chemistry

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).

09-445 Undergraduate Research

Fall and Spring

Properly qualified students may undertake research projects under the direction of members of the faculty, normally 6 to 12 hrs/week. A written, detailed report describing the project and results is required. Course may be taken only with the consent of a faculty research advisor in chemistry or on occasion in another department provided that the project is chemical in nature and with permission of the Director of Undergraduate Studies. 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. Maximum number of units taken per semester is 18.

09-455 Honors Thesis

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.)

09-502 Organic Chemistry of Polymers

Spring: 9 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

09-507 Nanoparticles

Intermittent: 9 units

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.

09-509 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 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.
Prerequisites: 09-345 or 09-347

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)
Prerequisites: 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 chemistry and biology. 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 then 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 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. (This course is also listed as 06-620.)
Prerequisites: 21-260 or 09-231
Corequisites: 09-344, 09-347

09-521 Bioinorganic Chemistry

Intermittent: 9 units

The 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.
Prerequisites: 09-348

09-525 Transition Metal Chemistry

Intermittent: 9 units

This class 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. Prerequisites: 09-348

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, LDI 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 and end group determination are covered. Hyphenated techniques such as GC/MS, LC/MS, and LC/QTOF MS are covered as well as hybrid mass analyzers (e.g., linear ion trap/orbitrap). Various MS scan modes (i.e., SIM, SRM, MS/MS) and basic spectrum interpretation are covered. Students are exposed to QET and RRKM 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 Molecular Modeling and 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

Language Technologies Institute

11-411 Natural Language Processing

Spring: 12 units

This course will introduce 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. Prerequisites: 15-211

Department of Civil and Environmental Engineering

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.

Corequisites: 12-100, 21-122, 33-106

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.

Prerequisites: 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.

Prerequisites: 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 spread-sheets, 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

Corequisite: 12-355

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.

Prerequisites: 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 substances 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 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.

Corequisites: 21-259, 21-260

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.

Prerequisites: 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.

12-411 Engineering Economics

Fall: 6 units

includes an introduction to construction project management from the 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, economic evaluation and financing of constructed facilities. Contracting, construction planning and fundamental scheduling procedures. Cost control, monitoring and accounting for construction. In Fall 2011, this course number will be changed to 12-421.

Prerequisites: 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, plines, 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 Special Topics: 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

Spring: 9 units

Introduction to steel, concrete, wood, and masonry construction methods and material selection; integration of design and constructability criteria; conformance of designs to applicable building and fire codes; preparation of plans and specifications; laboratory demonstration and experiments. Instructor approval.

Prerequisites: 12-231

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 international 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

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. In Fall 2011, this course will be a core course for all CEE undergraduates, the new course number will be 12-411.

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.

Prerequisites: 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.

Prerequisites: 12-231

Corequisites: 12-358, 27-357

12-635 Structural Analysis

Fall: 9 units

Matrix Algebra. Introduction to the Stiffness Method - spring element, direct stiffness method, stiffness assembly, boundary conditions, potential energy approach; one-dimensional governing equations for heat flow, axial bar, transversely loaded spring, diffusion, electric current, laminar pipe flow; truss analysis; beam analysis; frame and grid analysis, arbitrarily oriented beam in space, substructure analysis; plane stress and plane strain analysis, equations of elasticity, constant strain triangle, body and surface forces, linear strain triangle; axisymmetric elements; isoparametric formulation, bar element, rectangular elements, Gaussian quadrature, high order shape functions.

Prerequisites: 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.
Prerequisites: 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.

Prerequisites: 12-351

Coresquisite: 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, bulkheads, breakwaters, marinas, and harbors. Key related concepts from surface and ground water hydrology, and wave mechanics. This course is offered every other spring semester.
Coresquisite: 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

The purpose of this course is to 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.

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

School of Computer Science

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 student 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.

15-102 Exploring Programming with Graphics

Fall and Spring: 10 units

The course is intended for student with little or no prior programming experience and need a one semester experience with programming. The course will use graphics to present and study the traditional programming constructs and the fundamental algorithms typically found in a first course in programming. The course will develop these skills through assignments that have a graphical component using Processing, a graphical extension of Java. The assignments will vary from whimsical to the animation of time-series data from the student's area of study or research in a meaningful way. Types, variables, control, user input, arrays and files will play a major part of the programming assignments. Students will use some of the traditional Java classes (e.g., String) as well as define and instantiate objects of their own classes. Students will be exposed to the binary and hex number systems and recursion.

15-103 Principles of Computation

All Semesters: 6 units

15-105 Principles of Computation

Fall and Spring: 9 units

An introduction to principles that form the foundation of computer science for students with no prior background in computing. This course is suitable for students with a non-technical background who wish to study the key principles of computer science rather than just computer programming. Topics include the history of computation, writing algorithms and using programming constructs, data organization, the role of the compiler, programming language paradigm, recursion, algorithm correctness and efficiency, limits of computability and the Turing machine as a universal computer, the role of the operating system, an introduction to artificial intelligence, and alternative models of computation including parallel, quantum and molecular computing. Although programming principles and programming languages will be discussed, there will be no significant programming exercises in this class. Students who are interested in learning how to program in a specific programming language such as Java are encouraged to register for 15-110, 15-117 or 15-121 instead, depending on their prior programming background. Students who have completed 15-211 (or higher) are not permitted to register for this course.

15-110 Principles of Computing

All Semesters: 10 units

NOTE: This course is being significantly redesigned for F10. A new course description will be forthcoming. This description is for instances of the course prior to F10. An introduction to the process of program design and analysis using the Java programming language for students who have NO prior programming experience. Topics to be covered include basic data types and their operators, I/O, control structures (selection, loops), classes (including methods and fields), arrays, and simple sorting and searching algorithms. Students with prior programming experience are strongly encouraged to take 15-121. If you've taken a programming course in a language other than Java and have used functions, loops, and arrays, you should NOT enroll in 15-110 and instead enroll in 15-121. 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: 15-110 or 15-117

15-122 Principles of Imperative Computation

Fall and Spring: 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 basic 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.

15-123 Effective Programming in C and UNIX

All Semesters: 9 units

This course is designed to provide a substantial exposure to the C programming language and the Unix programming environment for students with prior programming experience but minimal exposure to C. Features of the C language that are emphasized include arrays, structs and unions, dynamic memory allocation (malloc and free), pointers, pointer arithmetic, and casting. Data structures that are emphasized include lists and hash tables. Students will develop a sense of proper programming style in the C idiom, and will be exposed to cross-platform portability issues. Students will learn to use tools such as emacs/vi, make, and gdb to assist them in the design, testing and debugging of their programs. Students will learn about regular expressions and grep and will be able to use a scripting language such as Perl to solve simple problems. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for 15-213.

Prerequisites: 15-110 or 15-117

15-128 Freshman Immigration Course

Fall: 1 unit

The Freshman Immigration Course is taken by first-semester Computer Science majors. The course is designed to acquaint incoming majors with computer science at CMU. Talks range from historical perspectives in the field to descriptions of the cutting edge research being conducted. 15-128 is a one unit course and is graded pass/fail. Enrollment is limited to SCS Freshmen ONLY.

15-129 Freshman Immigration Course II

Spring: 3 units

Students and instructors will solve different problems each week by searching the Web and all other likely places for answers. The problems will be submitted by outside people who will grade the quality of the answer. 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

15-211 Fundamental Data Structures and Algorithms

All Semesters: 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 pre-requisite for any subsequent Computer Science course.

Prerequisites: 15-121 and 21-127

15-212 Principles of Programming

Fall and Spring: 12 units

This course presents principles and techniques of programming, focusing on sophisticated methods for specifying, constructing, and reasoning about computer programs. Via features of a high-level functional programming language (currently ML), this course concretely illustrates mechanisms for building user-defined data types, including recursive and polymorphic types, and infinite data structures such as streams; for building higher-order control constructs such as first-class functions and continuations; and for building large programs using advanced module composition. It also introduces the use of formal methods for specifying and verifying programs.

Prerequisites: 15-251

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 pre-requisite for any subsequent Computer Science course.

Prerequisites: 15-123

15-221 Technical Communication for Computer Scientists

Fall and Spring: 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.

Prerequisites: 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 pre-requisite for any subsequent Computer Science course.

Prerequisites: (15-110 or 15-121) 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.

Prerequisites: 15-211

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: 15-212

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.

Prerequisites: 15-211 and (15-212 or 15-213)

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: 15-212

15-321 Research Methods for Experimental Computer Science

Fall

The success or failure of an experiment can turn on the details of how the experiment was performed — the experimental method. It is critical that the methodology be consistent with whatever research hypothesis is being pursued. The goal of this project-based course is to give students familiarity with and appreciation for the subtleties of a range of experimental techniques essential to high-quality empirical research. The course is based on a project that will illustrate important concepts of research methods. Example topics include user-study design and operation, data gathering, data diagnosis, experiment design and execution, signal detection, performance evaluation, error analysis, reporting results, etc. The project will explore the challenging open problem of keystroke dynamics, a biometric regime which seeks to identify/authenticate/discriminate users on the basis of their typing styles. In this context, numerous methodological issues provide the stimulus for learning how to perform empirical research from the beginning to the end of a project. Lectures will present necessary background material about the problem area and experimental methods; homework assignments and a team project will give students guided, hands-on, research and practical experience. At the end of the course, students will be acquainted with the basic issues in experimental methods, and will be able to perform independent work using the lessons learned and resources provided. Enrollment is limited to graduate students, juniors, and seniors. It will be helpful for students to have some experience with scripting languages (e.g., Perl, Python, Tcl, etc), statistically-oriented packages (e.g., R, Matlab, Weka) or other implementations of various machine-learning-type classifiers. This course can be used to satisfy the Lab requirement for the Computer Science major.

Prerequisites: 15-213

15-322 Introduction to Computer Music

Spring: 9 units

Computers are used to synthesize sound, process signals, and compose music. Personal computers have replaced studios full of sound recording and processing equipment, completing a revolution that began with recording and electronics. In this course, students will learn the fundamentals of digital audio, basic sound synthesis algorithms, and techniques for digital audio effects and processing. Students will apply their knowledge in programming assignments using a very high-level programming language for sound synthesis and composition. In a final project, students will demonstrate their mastery of tools and techniques through music composition or by the implementation of a significant sound-processing technique.

Prerequisites: 15-110

15-323 Computer Music Systems and Information Processing

Fall: 9 units

This course presents concepts and techniques for representing and manipulating discrete music information, both in real time and off line. Representations of music as explicitly timed event sequences will be introduced, and students will learn how to build efficient run-time systems for event scheduling, tempo control, and interactive processing. The MIDI protocol is used to capture real-time performance information and to generate sound. The course will also cover non-real-time processing of music data, including Markov models, style recognition, computer accompaniment, query-by-humming, and algorithmic composition. This course is independent of, and complementary to 15-322, Introduction to Computer Music, which focuses on sound synthesis and signal processing.

Prerequisites: 15-211

15-354 Computational Discrete Mathematics

Fall: 12 units

This course is about the computational aspects of some of the standard concepts of discrete mathematics (relations, functions, logic, graphs, algebra, automata), with emphasis on efficient algorithms. We begin with a brief introduction to computability and computational complexity. Other topics include: iteration, orbits and fixed points, order and equivalence relations, propositional logic and satisfiability testing, finite fields and shift register sequences, finite state machines, and cellular automata. Computational support for some of the material is available in the form of a Mathematica package.

Prerequisites: 15-251

15-355 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.

Prerequisites: 15-251

15-359 Probability and Computing

Fall: 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: 15-211 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. satisficing 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: 15-211

15-384 Robotic Manipulation

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: (15-121 or 15-123) and (18-202 or 21-241 or 24-311)

15-385 Computer Vision

Spring: 9 units

An introduction to the science and engineering of computer vision, i.e. the analysis of the patterns in visual images with the view to understanding the objects and processes in the world that generate them. Major topics include image formation and sensing, Fourier analysis, edge and contour detection, inference of depth, shape and motion, classification, recognition, tracking, and active vision. The emphasis is on the learning of fundamental mathematical concepts and techniques and applying them to solve real vision problems. The discussion will also include comparison with human and animal vision from psychological and biological perspectives. Students will learn to think mathematically and develop skills in translating ideas and mathematical thoughts into programs to solve real vision problems.

Prerequisites: 15-123 and (18-202 or 21-241)

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: 15-110 and 21-122

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

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.

Prerequisites: 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. (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.

Prerequisites: 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.

Prerequisites: 15-410

15-413 Software Engineering Practicum

Spring: 12 units

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.

Prerequisites: 15-313

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 Arian 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 Fundamentals of Algorithms requirement for the Computer Science major.

Prerequisites: 15-211 and 15-251

15-415 Database Applications

Fall: 12 units

This course covers the fundamental topics for Database Management Systems: Database System Architectural Principles (ACID properties; data abstraction; external, conceptual, and internal schemata; 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: SQL, 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: 15-211 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.

Prerequisites: 15-213 or 18-347

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: 15-211

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.

Prerequisites: 15-211

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 scarcity, 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.

Prerequisites: 15-211 and 15-213

15-441 Computer Networks

Fall and Spring: 12 units

15-441 is an introductory course in computer networks. The emphasis will be on the basic performance and engineering tradeoffs 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: congestion/flow/error control, routing, addressing, naming, multi-casting, switching, internetworking, and network security. Evaluation is based on homework assignments, the projects, and two mid-term exams.

Prerequisites: 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: 15-211 and 15-251

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: 15-211 and 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: (15-213 and 21-241 and 21-259) 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 and view 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 story-boarding, 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.

Prerequisites: 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 CFA room 303.

Prerequisites: 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.

Prerequisites: 15-462

15-482 Human Language Technologies

Fall: 12 units

During the last decade computers have begun to understand human languages. Web search engines, language analysis programs, machine translation systems, speech recognition, and speech synthesis are used every day by tens of millions of people in a wide range of situations and applications. This course covers the fundamental statistical and symbolic algorithms that enable computers to work with human language, from text processing to understanding speech and language. It provides detailed coverage of current techniques, their successes, their limitations, and current research directions. Homework assignments give hands-on experience with four different language technologies, using Internet Movie Database (IMDB) data.

Students write programs that answer questions about movies using information obtained from a search engine or a structured database, automatically select good translations of French movie titles, and read movie information in computer-generated voices that sound as natural as possible.

Prerequisites: 15-211

15-485 Computational Perception

Intermittent: 9 units

The goal of this course is to teach how to reason scientifically about problems and issues in perceptual cognition, how to extract the essential computational properties of those abstract ideas, and finally how to convert these into explicit mathematical models and computational algorithms. The course teaches advanced aspects of perception, scene analysis, and recognition in both the visual and auditory modalities, concentrating on those aspects that allow us and animals to behave in natural, complex environments. Both the experimental approaches of scientific disciplines and the computational approaches of engineering disciplines are emphasized. Each topic in the course begins by studying the ethology of natural behaviors, analyzing and decomposing these to identify the essential components that are required for the total behavior in a natural environment. This aspect of the course follows the lines of scientific reasoning and key experimental results that lead to our current understanding of the important computational problems in perception and scene analysis. The course then surveys the most important solutions to these problems, focusing on the idealizations and simplifications that are sensory coding, perceptual invariance, spatial vision and sound localization, visual and auditory scene segmentation, many aspects of attention, and the basics of objects and speech recognition.

Prerequisites: 15-385 or 85-370

15-490 Special Topic: Computational Neuroscience

Intermittent: 9 units

An introduction to computational neuroscience, i.e. the application of computational and mathematical concepts and techniques to the study of the brain. Students will learn the fundamentals of signals and systems, pattern analysis, probability theory and information theories and apply these techniques to study how the real nervous systems compute, communicate and learn at many levels, from synapses to neurons, from neuronal populations to systems. Topics include basic anatomy and physiology of neurons and the mammalian nervous systems, biophysics of single neurons, excitable membranes and cable equation, encoding and decoding of information in single neurons and neuronal ensembles, neural adaptation and learning, signal detection and reconstruction, distributed and hierarchical computations. Concrete examples will be drawn from visual and motor systems and studied from both biological and computational perspectives. Students will do a number of Matlab programming and mathematical exercises to consolidate their learning, participate in the analysis of real neuronal data. No prior background in biology is assumed. A graduate option of the course is offered concurrently to graduate students from all disciplines in science and engineering, including psychology and computational biology.

Prerequisites: 15-113 and (18-202 or 21-241)

15-492 Special Topic: Speech Processing

Intermittent: 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.

Prerequisites: 15-211

15-494 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, such as visual routines, dual coding theory, and affordances. Students will experiment with these primitives and help develop new ones using the Tekkotsu software framework on the Sony AIBO robot dog. Prior robotics experience is not necessary, but strong programming skills are required.

Prerequisites: 15-211 and 15-213

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**15-549 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.

Robotics

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: 15-211 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. <P> In course projects, students construct robots which are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students usually work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. <P> This course will also expose students to some of the contemporary happenings in robotics, including current robot lab research, applications, robot contests and robot web surfing.

Prerequisites: 15-121 or 15-123 or 21-122

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.

16-421 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 1500's "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 includes a host of lenses and mirrors.

Prerequisites: 21-111 and 21-241

Software Engineering

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 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

Department of Electrical and Computer Engineering

18-050 Study Abroad

Fall

18-051 Study Abroad

Spring

Students are encouraged to various international collaborative programs offered through the department of Electrical and Computer Engineering.

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 to students the 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.

Prerequisites: 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

18-220 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, layout, operational amplifiers, filters, signal detection and processing, power converters and circuit transients. 3 hrs. lec., 1 hr. rec., 3 hrs. lab.

Prerequisites: 18-100

Corequisite: 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 digital design software and actual hardware implementation laboratories to learn about real digital systems. 3 hr. lec., 1 hr. rec., 3 hr. lab.

Prerequisites: 18-100

Corequisite: 21-127

18-243 Introduction to Computer Systems

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 pre-requisite for any subsequent Computer Science course. Prerequisites: 15-123 (Grade of C or higher is required in the prerequisite)

Prerequisites: 15-123

18-290 Signals and Systems

Fall: 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. Prerequisite(s): 18-100 Corequisite(s): 18-202

Prerequisites: 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, quasistatic 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, quasistatic 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.

Prerequisites: 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.)

Prerequisites: 18-220

18-321 Analysis and Design of Analog Circuits

Spring: 12 units

The purpose of this course is to introduce the student to the fundamentals of the analysis and design of basic analog circuits. Topics to be covered include: operational amplifier design, basic amplifier feedback theory, frequency stability and compensation, dc bias calculations and circuits, MOSFET and BJT large- and small-signal device models, small-signal gain and frequency response characteristics of amplifiers, large-signal characteristics and nonidealities. In the hardware laboratory the student will gain experience designing, building, and characterizing analog circuits. The students will also learn how to use the SPICE circuit simulation program to compare actual and simulated performance. The analysis and design of analog circuits incorporating both Bipolar and CMOS technologies will be considered. 3 hrs. lec., 1 hr. rec., 3 hrs. lab.

Prerequisites: 18-220

18-322 Analysis and Design of Digital Circuits

Fall: 12 units

This course is intended to provide the electrical and computer engineering student with a familiarity to and an understanding of the analytical and computer skills required for the analysis, computer simulation, design, and computer-aided physical layout of digital integrated circuits. This course is preparatory for study in the fields of Very Large Scale Integrated (VLSI) circuits and Computer-Aided Design techniques. The lab focuses on the systematic analysis and design of digital integrated circuits in CMOS technology using CADENCE Design Systems software tools.

Prerequisites: 18-220 and 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 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.

18-332 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 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.

18-340 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.

Prerequisites: 18-240

18-341 Logic Design Using Simulation, Synthesis, and Verification Techniques

Spring: 12 units

The design of digital integrated circuits has grown in complexity to where computer-aided design tools are required for designers to work in an economically productive manner. This course is a study of the techniques of designing the register-transfer and logic levels of complex digital systems using simulation, synthesis, and verification tools. Topics will include memory, bus and communication system interfacing, asynchronous state machines, discrete-event simulation, fault models and test generation, debugging and testbench strategies, and assertion-based verification. Design examples will be drawn from memory systems, 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, such as SystemVerilog, will serve as the basis for uniting these topics. Quizzes, homeworks and design projects will serve to exercise these topics.

Prerequisites: 18-240

18-342 Fundamentals of Embedded Systems

Fall: 12 units

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.

Prerequisites: 18-240

18-345 Introduction to Telecommunication Networks

Fall: 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: (15-113 or 15-123) and 18-240 and 36-217

18-348 Embedded Systems Engineering

Fall: 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, serial ports, control); system-level engineering (design cycle, architectural patterns); real-time operation (timers, interrupts, concurrency); 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, 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
Prerequisites: (15-213 or 18-243) and 18-240

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/device and memory 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.
Prerequisites: (15-213 and 18-243) and 18-240

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: 18-396

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 approximately 8 months in uninterrupted length. 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 Office. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE's website.

18-396 Signals and Systems

Fall and Spring: 12 units

This course is a breadth course that also is a prerequisite for most courses in communications, signal processing and control systems. The objective of this course is to provide students with an integrated understanding of the relationships between mathematical tools and properties of real signals and systems. This is accomplished by motivating lectures and recitation problems using demonstrations and laboratory assignments which cover such topics as radio transmission and reception, audio synthesizers, CDs, image processing, and prosthetic devices. In the course of the semester, students are introduced to industry-standard computing and simulation tools that will be used in subsequent courses. Continuous and discrete-time signals and systems are treated in a unified manner through the concept of sampling. The course covers the basic concepts and tools needed to perform time and transform domain analyses of signals and linear time-invariant systems, including: unit impulse response and convolution; Fourier transforms and filtering; Laplace transforms, feedback and stability; and a brief introduction to z-transforms in the context of digital filtering.
Prerequisites: 18-202 and 18-220

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 quasistatic 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.
Prerequisites: 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.
Prerequisites: 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

18-412 Field Effect Devices and Technology

Fall: 12 units

This course follows 18-310, which provides an introduction to the physics of semiconductor devices. 18-412 addresses in detail the physics of semiconductor devices which work on the field effect principle, which are today technologically and economically dominant. These devices include the MOSFET, junction field effect devices (JFET and MESFETs), thin film field effect transistors (TFTs), and related devices. The course material is specifically motivated by current applications in which portable and low power operation is required. Particular applications which are discussed in detail include scaled MOSFETs for logic and memory; CCD imagers; active matrix flat panel displays; and MESFETs for digital and RF applications. This semester: The evolution continues, this course increasingly will incorporate more content on semiconductor process technology. I believe that an increasing degree of understanding of processing and its limitations is needed in order to make sense of current issues in device physics. There will be several lectures on process technology at the beginning of the course. This is the result of an evolving convergence of this course with my graduate processing course 18-815, (not expected to be offered in the near future).

Prerequisites: 33-107 and (18-310 or 18-311)

18-413 Introduction to Computer-Aided Instrumentation and Characterization

Intermittent: 12 units

This course introduces students to the use of Labview, a commonly used tool for instrument control. In addition, a number of essential aspects of measurement hardware and measurement technology will be studied. Students will develop a fundamental understanding of important issues encountered in instrumentation and device characterization, including accuracy, resolution, noise, parasitics, and grounding that will enable students to critically assess their data and to rapidly develop solutions to new measurement problems. In addition, this course will encourage a systematic approach to the development of instrument control software, including overall planning, partitioning into testable and reusable pieces, incorporation of error detection and error handling, and provision of a user-friendly interface.

Prerequisites: 18-310 or 18-311 or 18-321

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 fabless 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.

Prerequisites: 18-322

18-416 Data Storage Systems

Fall: 12 units

This course teaches the fundamentals of magnetic and optical recording technology as used in data storage systems, audio and video recording. It begins with a treatment of systems considerations, including data rate, storage capacity, and formats of various tape and disk systems. It then moves on to treat the details of the writing and readback processes including descriptions of the heads and media. The concepts in magnetic materials and electromagnetics required to understand these devices are also covered. Lectures and problem sets are supplemented by six laboratories in which students record, readback, analyze actual signals, and operate magnetic and magnetoresistive devices. 3.0 hrs. lec., 3.0 hrs. lab (meets six times).

Prerequisites: 18-300 or 18-310

18-417 Optical Communications Systems

Fall: 12 units

(Formerly 18-315.) In this course, students will receive an introduction to the fundamental principles and components of optical communications. The course objective is to provide a basic understanding of present optical communication systems as well as future engineering challenges. The course covers the basic concepts of data modulation in optical fiber channels, channel multiplexing, wavelength division multiplexing, and fiber optics. The course also includes the basic function principles of optical fiber, light emitting diodes, lasers, optical amplifiers, optical filters, and optical receivers. 3 hrs. lec., 1 hr rec.

Prerequisites: 18-310

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 components 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.

Prerequisites: 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, and solar cell, etc. It provides students with 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

Prerequisites: 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

Fall and 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: (15-213 or 18-243) and 18-240

18-450 Digital Wireless 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"

Prerequisites: 18-396 and 36-217

18-470 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: 18-396

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 relevant 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 15-243) and (18-396 or 18-370)

18-482 Telecommunications, Technology Policy & Management

Fall: 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.

Prerequisites: 73-100

18-487 Introduction to Computer & Network Security & Applied Cryptography

Spring: 12 units

Security is becoming one of the core requirements in the design of critical systems. This course will introduce students to the introductory 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: 15-213 or 18-243

18-491 Fundamentals of Signal Processing

Spring and Summer: 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.

Prerequisites: 18-396

18-492 Special Topics: 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.

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

18-496 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.

Prerequisites: 18-396

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 (18-321 and 18-310) or (18-321 and 18-300) or (18-321 and 18-396) or (18-310 and 18-300) or (18-310 and 18-396) or (18-396 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 sub-systems, 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 as 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/tranciever 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 18-321) or 18-402

18-517 Data Storage Systems Design Project

Spring: 12 units

This course gives students a comprehensive understanding of data storage systems through lecture and simulation exercises. Over the course of the semester, students will work in teams to build a computer simulation of an entire disk drive recording channel, and observe the different forms that the stored information takes on its passage through a non-volatile storage system. As many realistic aspects of the storage system will be incorporated in the simulation as possible, including magnetic media hysteresis, magnetic and electronic noise, magnetoresistive readback sensors, and various methods of data detection. The class will culminate with demonstrations by each group of their models, and the effect the changes in recording parameters have on data integrity. Currently the SIMULINK package is used with Matlab to construct the simulation, and students are provided with a 3 hr. recitation period each week during which they can work on their simulation under the supervision of the course instructors. 3 hrs. lecture, 3 hrs. rec. Graduate students may have the pre-requisites waived. Prerequisites: 18-416 or 18-316 or 18-300 or 18-310

18-525 Integrated Circuit Design Project

Spring: 12 units

This course is intended to provide the electrical and computer engineering student with IC design experience. The primary stress of the 18-525 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 18-525 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 18-525 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. 4 hrs. class.

Prerequisites: 18-322 and (18-340 or 18-341 or 18-321 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 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 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 or 18-349 or (18-322 and 18-396) or (18-322 and 18-340) or (18-322 and 18-341) or (18-396 and 18-340) or (18-396 and 18-341)

18-544 Network Design and Evaluation

Fall: 12 units

The purpose of the "Network Design and Evaluation" is to give students hands-on experience building networking software. A typical project will be the design, implementation, and evaluation of a network protocol. The design will specify the requirements, protocol specification, and success criteria. The implementation will have to work over an actual network, and the evaluation will evaluate whether the success criteria have been met. Students will work in teams and will have a choice of a small number of projects.

Prerequisites: (15-213 or 18-243) and (18-345 or 15-441)

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: 18447 or (18340 and (15213 or 18243)) or (18341 and 15213). You can substitute 18360 for 18341.

Prerequisites: 18-447 or (18-340 and 15-213) or (18-341 and 15-213)

18-549 Embedded Systems Design

Fall: 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

18-551 Digital Communication and Signal Processing Systems Design

Fall: 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: 18-396 and (15-211 or 18-450 or 18-491 or 18-791 or 18-793 or 18-796 or 18-798)

18-578 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 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: 18-348 or 18-370 or 18-470 or 18-474 or 18-349 or (18-321 and 18-396)

18-699 Special Topics in Signal Processing

Spring: 12 units

Please refer to the ECE website for a full description of this course.
<http://www.ece.cmu.edu/undergraduate/guide/appendix-f.html>
Prerequisites: 36-217 and (18-290 or 18-396)

Department of Engineering and Public Policy

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 includes 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: 21-115, 21-116, 33-106

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.

19-402 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.
Prerequisites: 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 wifi computer networks, broadband to the home, broadcast radio and television, and satellite communications. This can 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.

19-424 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 as wide-ranging a discussion as possible. Those issues cover areas 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 thermochemical 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.

19-448 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.

19-687 Special Topics: Principles and Practices of R&D Management

Intermittent: 6 units

This course considers key issues and trade-off in R&D strategy and organization, paying attention to dynamic competitive contexts where technology plays a key role. These topics are treated assuming 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.

Department of Mathematical Sciences

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 been finite 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.
Prerequisites: 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'Hospital'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.

21-121 Integration and Differential Equations

Fall and Spring: 10 units

Differentiation review, L'Hospital's Rule, Mean Value Theorem, maximum-minimum problems. Definite and indefinite integrals; hyperbolic functions; applications of integration, integration by substitution and by parts. 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. 3 hrs. lec., 2 hrs. rec.
Prerequisites: 21-115

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: 21-112 or 21-120 or 21-121

21-123 Calculus of Approximation

Fall and Spring: 5 units

Newton's method, Taylor's Theorem including a discussion of the remainder, sequences, series, power series. 3 hrs. lec., 2 hrs. rec.
Prerequisite: 21-121

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: 9 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.

21-131 Analysis I

Fall: 10 units

An enriched first course in calculus, which includes a greater concentration on the foundations of the subject. Recommended for students with some prior background in calculus and who seek a deeper calculus course. Functions, limits, continuity; the Intermediate Value Theorem; the Riemann integral; the Fundamental Theorem of Calculus; integrability of continuous functions; the derivative and its significance; product rule, quotient rule, chain rule; Mean Value Theorem; inverse functions. 3 hrs. lec., 2 hrs. rec.

21-132 Analysis II

Spring: 10 units

A continuation of Analysis I. L'Hospital's rule; trigonometric, logarithmic, and exponential functions; techniques of integration; approximation by polynomials, Taylor's theorem; sequences, series, power series; introduction to linear differential equations. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21-131

21-201 Undergrad 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.

Prerequisites: 21-127

21-235 Mathematical Studies I

Fall: 20 units

A unified and intensive presentation of algebra, analysis, and geometry by a team of instructors. For capable and dedicated students who can allot a substantial amount of time to the study of mathematics. Aims at providing a modern background in mathematics for a career in pure or applied mathematics, science, or engineering. Topics covered include analysis in IR, analysis in Euclidean spaces, linear algebra, geometry, algebraic theories, multi-linear algebra, ordinary differential equations. Covers and extends the material in the courses Calculus in Three Dimensions, Advanced Calculus I and II, Algebraic Structures, and Linear Algebra I. Normally taken by students in the third semester. Participation by invitation. Interested Freshmen should contact the Department in March.

Prerequisites: 21-132

21-236 Mathematical Studies II

Spring: 20 units

A unified and intensive presentation of algebra, analysis, and geometry by a team of instructors. For capable and dedicated students who can allot a substantial amount of time to the study of mathematics. Aims at providing a modern background in mathematics for a career in pure or applied mathematics, science, or engineering. Topics covered include analysis in IR, analysis in Euclidean spaces, linear algebra, geometry, algebraic theories, multi-linear algebra, ordinary differential equations. Covers and extends the material in the courses Calculus in Three Dimensions, Advanced Calculus I and II, Algebraic Structures, and Linear Algebra I. Normally taken by students in the fourth semester. On completion a number of options are open, among them the Honors Degree Program. Participation by invitation.

Prerequisites: 21-235

21-241 Matrix Algebra

All Semesters: 9 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. 3 hrs. lec.

21-256 Multivariate Analysis and Approximation

All Semesters: 9 units

Taylor's Theorem; geometric sequences and series and their applications in compound interest; vectors and matrices, lines, and planes; partial derivatives, directional derivatives, gradient, chain rule, maximum-minimum problems, Lagrange multipliers and the Kuhn-Tucker Theorem. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21-112 or 21-120 or 21-121

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 salesman problem, and an introduction to set covering models. 3 hrs. lec., 1 hr. rec.

Prerequisites: 06-262 or 18-202 or 21-241 or 21-256 or 21-341

21-259 Calculus in Three Dimensions

All Semesters: 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., 2 hrs. rec.

Prerequisites: 21-112 or 21-120 or 21-121

21-260 Differential Equations

All Semesters: 9 units

Ordinary differential equations: first and second order equations, applications, Laplace transforms; partial differential equations: partial derivatives, separation of variables, Fourier series; systems of ordinary differential equations; applications. 3 hrs. lec., 1 hr. rec.

Prerequisites: 21-122 or 21-123 or 21-132

21-270 Introduction to Mathematical Finance

Spring: 9 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.

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.

21-300 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 (21-132 or 21-228 or 21-373 or 21-484)

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 21-127

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 a variety of models arising in computational biology, finance, engineering and computer science. The firm grounding in the fundamentals is aimed at providing students the flexibility to build 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.

21-341 Linear Algebra

Fall and Spring: 9 units

A mathematically rigorous introduction to Linear Algebra. This course will teach the student how to write clear, rigorous, proofs in a more abstract setting than in 21-127. Topics studied will include abstract vector spaces, linear transformations, eigenvalues, eigenvectors, inner products, invariant subspaces, spectral theorem, singular value decomposition and determinants. 3 hrs. lec.

Prerequisites: 21-127

21-342 Linear Algebra II

Intermittent: 9 units

General spectral theory, invariant subspaces, canonical forms, duality and multilinear algebra, bilinear forms, quotient spaces, direct sums, tensor products, normal transformations in inner product spaces.

Applications of linear algebra: Possible topics include combinatorics, coding theory, cryptography, differential equations, finite symmetry groups. 3 hours lecture.

Prerequisites: 21-341

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

The Real Number System: Field and order axioms, sups and infs, completeness, integers and rational numbers. Real Sequences: Limits, cluster points, limsup and liminf, subsequences, monotonic sequences, Cauchy's criterion, Bolzano-Weierstrass Theorem. Topology of the Real Line: Open sets, closed sets, density, compactness, Heine-Borel Theorem. Continuity: attainment of extrema, Intermediate Value Theorem, uniform continuity. Differentiation: Chain Rule, local extrema, Mean-Value Theorems, L'Hospital's Rule, Taylor's Theorem. Riemann Integration: Partitions, upper and lower integrals, sufficient conditions for integrability, Fundamental Theorem of Calculus. Sequences of Functions: Pointwise convergence, uniform convergence, interchanging the order of limits. 3 hours lecture.

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 calculus: 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

21-357 Sequences and Series of Functions

Fall: 9 units

This course serves as a sequel to Advanced Calculus I. The course begins with a thorough coverage of uniform and pointwise convergence of sequences and series of functions. This is followed by application to power series and Fourier series. Additional topics may include (at the discretion of the instructor and as time permits) the Weierstrass approximation theorem, metric spaces, contraction mapping, existence of solutions to ODEs, the Arzela-Ascoli theorem, and wavelets. 3 hrs. lec.

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

Typical of 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.

Prerequisites: 21-241

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)
Corequisites: 21-325, 36-217, 36-225, 70-207

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

Groups: Homomorphisms. Subgroups, cosets, Lagrange's theorem. Conjugation. Normal subgroups, quotient groups, first isomorphism theorem. Group actions, Cauchy's Theorem. Dihedral and alternating groups. The second and third isomorphism theorems. Rings: Subrings, ideals, quotient rings, first isomorphism theorem. Polynomial rings. Prime and maximal ideals, prime and irreducible elements. PIDs and UFDs. Noetherian domains. Gauss' lemma. Eisenstein criterion. Fields: Field of fractions of an integral domain. Finite fields. Applications to coding theory, cryptography, number theory. 3 hours lecture.

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.

Prerequisites: 21-373

21-393 Operations Research II

Fall: 9 units

An important goal of this course is for the student to gain experience with the process of working in a group to solve a problem. Much of the course is devoted to a group project based upon case studies and methods presented. Topics may include combinatorial optimization, game theory, integer programming, heuristic methods. 3 hrs. lec.

Prerequisites: 21-257 or 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.

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: 21-127 and 21-241

21-450 Topics in Geometry

Intermittent: 9 units

Typical of courses, which are offered from time to time are convex sets, differential geometry, projective geometry, and classical geometry. 3 hrs. lec.

Prerequisites: 21-356 or 21-460

21-460 Topology

Intermittent: 9 units

This course introduces the topological concepts that underlie analysis. Included are metric spaces, topological spaces, separation, compactness, convergence, and connectedness. Also included are constructions and concepts in topological spaces that parallel those found elsewhere in mathematics such as quotients, products, sums, factorization of mappings, and isomorphisms. Other topics included as time permits according to the interests of the instructor. 3 hrs. lec.

Prerequisites: 21-355

21-465 Topology and Geometry

Spring: 9 units

Review of metric spaces. Topological spaces. Separation axioms. Open, closed and compact sets. Continuous functions. Product spaces, subspaces, quotient spaces. Connectedness and path-connectedness. Homotopy. Fundamental group of a pointed space. Simply connected spaces. Winding number, the fundamental group of the circle. Functorial property of the fundamental group. Brouwer fixed point theorem. Covering spaces. van Kampen's theorem. 2-manifolds. Triangulations. Euler characteristic. Surgery, classification of 2-manifolds. Riemannian manifolds, length, angle and curvature. Geodesics. The upper half plane, action of $SL_2(\mathbb{Z})$, fundamental region. 3 hours lecture.

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 finite difference equations, calculus of variations, and applied control theory. 3 hrs. lec.

Prerequisites: (21-236) or (21-241 and 21-355)

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: 21-127

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.

Prerequisites: 21-127 and 21-241 and 21-259 and 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.

Department of Mechanical Engineering

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 CIT freshmen. 3 hrs. lec., 2 hrs. rec./lab.

Corequisites: 21-115, 21-116, 33-106

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. rec., 3 hrs. lab.

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.

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 similitude 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

Prerequisites: 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 and 24-231 and 24-322

24-322 Heat Transfer

Fall: 10 units

Introduction to basic concepts of engineering heat transfer. Steady and transient heat conduction in solids, including the effect of heat generation. Finned surfaces. Correlation formulas for forced and free convection, condensation, and boiling. Design and analysis of heat exchangers. Radiation heat transfer. Problems in combined convection and radiation. Measurement techniques. 3 hrs. lec., 1 hr. recitation.

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 co-generation 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 (drag), energy transfer (heat convection), and mass transfer (evaporation, etc.). 3 hrs. rec., 1 hr. lab

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

Development of the foundations of frictionless compressible flow. Internal flow with friction and heat transfer. Acoustics and wave motion. Oblique shocks and expansion waves. Two-dimensional subsonic and supersonic flow including hodograph transformations, linearized theory of thin airfoils, and the method of characteristics. Introduction to transonic and hypersonic flow and reentry problems. 3 hrs. rec.

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.

Prerequisites: 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. Prerequisites: 24-261

24-352 Dynamic Systems and Controls

Spring: 12 units

This second course on the modeling and analysis of dynamic systems emphasizes the common features, which are exhibited by physical systems that include mechanical, hydraulic, pneumatic, thermal, electrical, and electromechanical elements. State equations and the concepts of equilibrium, linearization, and stability are discussed. Time and frequency domain solutions are developed. 4 hr. lec. Prerequisites: 21-260 and 24-261 and 33-107

24-353 Intermediate Dynamics

Intermittent: 9 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.

Prerequisites: 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.

Prerequisites: 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

24-370 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 inter-relating them. Some hands-on assignments, including computational assignments, 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; and choose materials and manufacturing schemes. Co-requisites: 24-262 (stress analysis) and junior status Corequisite: 24-262

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.

24-392 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.

24-415 Microfluidics

Intermittent: 9 units

24-415 Microfluidics 9 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. 3 hrs lec. Prerequisites: 24-231 or 06-261 or 12-355 Cross-listed with 24-715

24-421 Internal Combustion Engines

Fall: 10 units

Basic principles and fundamentals of internal combustion engines; gas turbine, spark ignition and diesel compression ignition engines. Combustion chamber design. Monitoring and control of fuel efficiency and emission of pollutants in exhaust gases. Developments in direct injection, rotary, prechamber and stratified charge engines. Ignition, fuel injection, mixing and combustion processes, heat release, and energy balances. Engine laboratory projects include: air and fuel controls, measurement of particulate and species concentrations in exhaust gases. 3 hrs. rec., 1 hr. lab.
Prerequisites: 24-221 and 24-231
Corequisite: 24-322

24-423 Direct Energy Conversion

Intermittent: 9 units
Principles of energy conversion between various forms of energy including heat, electricity, and light. Applications. Theory of thermoelectric, thermionic, magnetohydrodynamic, and photovoltaic direct conversion devices. Principles of chemical and mechanical energy storage.

24-424 Energy and the Environment

Intermittent: 9 units
Fuel cycles for conventional and non-conventional energy resources; relationships between environmental impacts and the conversion or utilization of energy; measures of system and process efficiency; detailed study and analysis of coal-based energy systems including conventional and advanced power generation, synthetic fuels production, and industrial processes; technological options for multi-media (air, water, land) pollution control; mathematical modeling of energy-environmental interactions and tradeoffs and their dependency on technical and policy parameters; methodologies for energy and environmental forecasting; applications to issues of current interest.

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.

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)
Prerequisites: 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, time constants, transient response specifications, feedback controls such as PID control, and stability for single-degree-of-freedom and multi-degree-of-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
Corequisite: 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 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 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)
Prerequisites: 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 microensors. 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

Department of Materials Science and Engineering

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: 21-120, 33-106

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.

Prerequisites: 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 the 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.

Prerequisites: 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 the 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-relations 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: 21-259, 27-100

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, examples 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

Stability of structures. Hume-Rothery rules. Free energy-composition curves with applications to binary and ternary phase diagrams. Quantitative concepts of nucleation and growth with examples from solidification. Development of microstructures in various classes of phase diagram under near-equilibrium conditions. Atomic mechanisms of solid state diffusion and approach to equilibrium through diffusion.

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 courses 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 and 33-107

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 biological response. Cellular interactions with various surfaces and immunological responses will also be covered. Applications of biomaterials to be discussed include tissue engineering, artificial implants and devices. Part I of this course is offered in the Spring and focuses on the principles, properties and applications of polymers as biomaterials. 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 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 solid state based on the polymer's chemical 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 criteria, 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
Prerequisites: 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 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.

27-401 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 project course 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 of 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
Prerequisites: 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 fractures, and the sinking of the Titanic. 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 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.

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

Intermittent: 9 units

Fall even years 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

Intermittent: 9 units

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.
Prerequisites: 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 magnetostriction. 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 platinum. 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 polymeric 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 Biomaterials II

9 units

This is Part II of a two-part course sequence in Biomaterials. This introductory course will address 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 biological response. Cellular interactions with various surfaces and immunological responses will also be covered. Applications of biomaterials to be discussed include tissue engineering, artificial implants and devices. Part I of this course is offered in the Spring

and focuses on the principles, properties and applications of polymers as biomaterials. Prerequisites: None, but Introduction to Modern Chemistry (09105), Biomaterials-I (42-501), and Introduction to Biomedical and Health Engineering (42101) will be useful, though not required.

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 Prerequisites: 27-201 and 33-107

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.

27-560 Physical Chemistry of Metallurgical Reactions

Fall and Spring: 9 units

This course addresses the important rate controlling processes in high-temperature reactions, including gas phase mass transfer, free vaporizations, liquid phase mass transfer and heat transfer. It also discusses fundamental aspects of chemical kinetics, and analyzes the kinetics in selected technological processes. Each student in the course is assigned a published research paper, which he or she must defend or critique in a presentation to the class.

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 distinctively 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.

27-582 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 through 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.

Prerequisites: 27-215

Reserve Officers' Training Corps (ROTC)

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

Spring: 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 Sury 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.

Reserve Officers' Training Corps (ROTC)

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.

31-402 National Security Affairs and Preparation for Active Duty

Spring: 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.

Reserve Officers' Training Corps (ROTC)

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.

Department of Physics

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 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. One fifth of the course covers waves, including standing and travelling waves, superposition, beats, reflection, and interference. Two fifths of the course covers electricity, including electrostatics and electric fields, Gauss' law, electric potential, and simple circuits. The remaining two fifths cover 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: 10 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

33-132 Matter and Interactions II

Spring: 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

Spring: 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

33-228 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: 9 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: 9 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.

Prerequisites: 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 properties of angular momentum are developed and applied to central potentials in three dimensions. The one electron atom is then treated. Properties of collections 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.

Prerequisites: 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

Junior 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.

Prerequisites: 33-331

33-338 Intermediate Electricity and Magnetism I

Fall: 10 units

This course includes the basic concepts of electro- and magnetostatics. In electrostatics, topics include the electric field and potential for typical configurations, work and energy considerations, the method of images and solutions of Laplace's Equation, multipole expansions, and electrostatics in the presence of matter. In magnetostatics, the magnetic field and vector potential, magnetostatics in the presence of matter, properties of dia-, para- and ferromagnetic materials are developed.

Prerequisites: 21-259 and 33-232

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.

Prerequisites: 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.

Prerequisites: 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 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.

33-353 Intermediate Optics

Fall: 12 units

Geometrical optics: reflection and refraction, mirrors, prisms, lenses, apertures and stops, simple optical instruments, fiber optics. Scalar wave optics: wave properties of light, interference, coherence, interferometry, Huygens-Fresnel principle, Fraunhofer diffraction, resolution of optical instruments, Fourier optics, Fresnel diffraction. Laser beam optics: Gaussian beams. Vector wave optics: electromagnetic waves at dielectric interfaces, polarized light. The course will use complex exponential representations of electromagnetic waves.

Prerequisites: 33-107 or 33-112 or 33-132

33-355 Nanoscience and Nanotechnology

Fall: 9 units

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 nanostructures. 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

33-441 Introduction to BiPhysics

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 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 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 and 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.

Prerequisites: 33-234

Corequisite: 33-331

33-446 Advanced Quantum Physics II

Spring: 9 units

Classical symmetries; quantum symmetries; rotations and angular momentum; spin; addition of angular momentum; the hydrogen atom; quantum "paradoxes" and Bell's theorem; applications.
Prerequisites: 33-445

33-448 Introduction to Solid State Physics

Spring: 9 units

This course gives a quantitative description of crystal lattices, common crystal structures obtained 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 precede 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.

Prerequisites: 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 beautiful theory - 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.

Department of Statistics**36-149 Statistics Freshman Seminar**

Fall and Spring: 9 units

Biomedical Imaging - What Can We See? Technological advances have made it possible to see inside a living animal, say, a human, and study its structure, and in some cases, its function. None of the imaging methods work like a traditional camera with film. This course will look at the details of several of these imaging technologies to understand how the images are constructed and what spatial and temporal resolution is possible. We will consider some of the reasons why an image might not actually look like the target tissue and we will visit a few of the imaging facilities to see the equipment in action. Specific technologies we'll consider include digital cameras and video, Xray, MRI, PET, and MEG, and may include NIRS, CT, TPLSM, and SPECT.

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 applications of particular interest to H&SS students. Not open to students who have received credit for 36-207/70-207, 36-220, 36-225, 36-625, or 36-247.

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 week for "hands-on" practice of the material covered in lecture. Not open to students who have received credit for: 36-208/70-208, 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 21-116 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: (21-116 or 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: 21-116 or 21-120 or 21-121 or 21-112

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 for students in economics, mathematics and 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 Probability and Statistics II

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 senior level courses. 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 36-226.

Prerequisites: 21-116 or 21-120 or 21-121 or 21-112

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 Data Mining

Fall: 9 units

The course will focus on how to construct hypotheses from a large data set and confirm them statistically. Exploratory methods include discriminant analysis, principal component analysis, projection pursuit, clustering, and nonparametric density estimation. Confirmatory methods include confidence intervals, posterior distributions, and Bayes factors. In addition, student will learn how to think in terms of probabilistic models and use data mining software effectively. Some computer programming required.

Prerequisites: 36-226 or 36-310 or 36-625

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.

Prerequisites: 36-226 or 36-310 or 36-626

36-402 Advanced Data Analysis

Spring: 9 units

The material in this course concentrates on methods for the analysis of data, building on the theory and application of the linear model from 36-401. Topics include repeated measures ANOVA, linear mixed models, analysis of categorical data, power calculation, and if time permits, other topics such as non-linear regression, classification, survival analysis and multivariate methods. Real-world examples will be drawn from a variety of fields. Students will analyze data and write reports.

Prerequisites: 36-401

36-410 Introduction to Probability Modeling

Spring: 9 units

An introductory-level course in stochastic processes. Topics typically include Poisson processes, Markov chains, birth and death processes, random walks, recurrent events, and renewal theory. Examples are drawn from reliability theory, queuing theory, inventory theory, and various applications in the social and physical sciences.

Prerequisites: 21-325 or 36-217 or 36-225 or 36-625

36-461 Topics in Statistics

Intermittent: 9 units

Epidemiology is concerned with understanding factors that cause, prevent, and reduce diseases by studying associations between disease outcomes and their suspected determinants in human populations. Epidemiologic research requires an understanding of statistical methods and design. Epidemiologic data is typically discrete, i.e., data that arise whenever counts are made instead of measurements. In this course, methods for the analysis of categorical data are discussed with the purpose of learning how to apply them to data. The central statistical themes are building models, assessing fit and interpreting results. There is a special emphasis on generating and evaluating evidence from observational studies. Case studies and examples will be primarily from the public health sciences.

Prerequisites: 36-226 or 36-310 or 36-626

36-462 Topics in Statistics

Intermittent: 9 units

In this special topics course, we will explore different supervised and unsupervised learning techniques (i.e. learning with and without labels) focusing more heavily on clustering and classification methodology. Emphasis will be on using these tools in practice and in particular for finding reduced group structure in multivariate high-dimensional data. We will also focus on diagnostics and validation of our methods (i.e. how do we know if we succeeded? Are there subgroups that need more analysis? Which observations are problematic?). Students will code their own classifiers and gain experience with the issues of large, complicated data sets.

Prerequisites: 36-226 or 36-310 or 36-626

36-463 Topics in Statistics

Intermittent: 9 units

Multilevel and hierarchical models are among the most broadly applied "sophisticated" statistical models, especially in the social and biological sciences. They apply to situations in which the data "cluster" naturally into groups of units that are more related to each other than they are the rest of the data. In the first part of the course we will learn about Bayesian statistical methods. In the second part we will relate multilevel and hierarchical models to other areas of statistics, and in the third part of the course we will build and apply these models using a variety of data sets and examples.

36-464 Applied Multivariate Methods

Intermittent: 9 units

This course is an introduction to applied multivariate methods. Topics include a discussion of the multivariate normal distribution, the multivariate linear model, repeated measures designs and analysis, principle component and factor analysis. Emphasis is on the application and interpretation of these methods in practice. Students will use at least one statistical package.

36-490 Undergraduate Research

Spring: 9 units

This course is designed to give undergraduate students experience using statistics in real research problems. Small groups of students will be matched with clients and do supervised research for a semester. Students will gain skills in approaching a research problem, critical thinking, statistical analysis, scientific writing, and conveying and defending their results to an audience. Eligible students will receive information about the application processes for this course early in the fall.

Prerequisites: 36-401

Corequisite: 36-402

MCS Interdisciplinary

38-210 BIOUS: 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, genomes, 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.

CIT Interdisciplinary

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 have 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 QPA 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.

Department of Biomedical Engineering

42-101 Introduction to Biomedical Engineering

Fall and Spring: 12 units

This course will provide exposure to basic biology and engineering problems associated with living systems and health care delivery. Examples will be used to illustrate how basic concepts and tools of science & engineering can be brought to bear in understanding, mimicking and utilizing biological processes. The course will focus on four areas: biotechnology, biomechanics, biomaterials and tissue engineering and bioimaging and will introduce the basic life sciences and engineering concepts associated with these topics. Pre-requisite OR co-requisite: 03-121 Modern Biology.
Corequisite: 03-121

42-200 Sophomore BME Research Project

Fall and Spring

Research projects for sophomores under the direction of a regular or courtesy BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects at local hospitals provided that a regular or courtesy 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 one-page project description with sign-off by the research advisor and a copy submitted for review and filing to the student's academic advisor. 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.

42-201 Professional Issues in Biomedical Engineering

Fall and Spring: 3 units

This course helps students learn to understand technical and professional challenges biomedical engineers face. First, it introduces students to applications of technology in medicine and biology. Second, it provides an overview of professional topics involving bioethics, regulatory issues, communication skills, team work, and contemporary issues. Outside speakers describe real world problems and professional issues in biotechnology and bioengineering, and progress toward their solution. Students have the opportunity to visit state-of-the-art laboratories in such areas as bioimaging, musculoskeletal biomechanics, rapid prototyping and manufacturing, and cardiac assist devices. Prerequisite or co-requisite: 42-101 Introduction to Biomedical Engineering
Prerequisites: 42-101

42-202 Physiology

Fall and Spring: 9 units

This course is an introduction to human physiology and includes units on all major organ systems. Particular emphasis is given to the musculoskeletal, cardiovascular, respiratory, digestive, excretory, and endocrine systems. Modules on molecular physiology tissue engineering and physiological modeling are also included. Due to the close interrelationship between structure and function in biological systems, each functional topic will be introduced through a brief exploration of anatomical structure. Basic physical laws and principles will be explored as they relate to physiologic function. Prerequisite or co-requisite: 03-121 Modern Biology, or permission of instructor.
Corequisite: 03-121

42-203 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. 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. Pre-med students should register for 03-206. Priority for enrollment will be given to students who have declared the Additional Major in Biomedical Engineering.

42-300 Junior BME Research Project

Fall and Spring

Research projects for juniors under the direction of a regular or courtesy BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects at local hospitals provided that a regular or courtesy 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 one-page project description with sign-off by the research advisor and a copy submitted for review and filing to the student's academic advisor. 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.

42-311 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.

Prerequisites: 09-105

42-312 Metallic and Ceramic Biomaterials

Intermittent: 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 biological response. Cellular interactions with various surfaces and immunological responses will also be covered. Applications of biomaterials to be discussed include tissue engineering, artificial implants and devices. Part I of this course is offered in the Spring and focuses on the principles, properties and applications of polymers as biomaterials. Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful. 42-312 is also known as 27-511.

Prerequisites: 09-105

42-321 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 and technologically relevant biochemicals. Topics to be covered include cellular and microbial metabolism, recombinant DNA methodologies, bioreactor design, protein separation and purification, and systems approaches to biotechnology. Prerequisites: (42-202 Physiology OR 03-121 Modern Biology OR 03-232 Biochemistry) AND (06-262 Mathematical Methods of Chemical Engineering OR 21-260 Differential Equations) OR permission of instructor.

Prerequisites: 06-262 and 42-202

42-334 Introduction to Computational Biology

Spring: 12 units

This course covers the application of computers to solve problems in biology and medicine. Since computers are increasingly used in biological research, the course is valuable for all biological sciences majors and double majors in biomedical engineering. It is intended for students without computer programming experience (students with a desire to apply programming methods to these problems should take the more advanced course 03-510, Computational Biology). 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 consists primarily of homework assignments making use of software packages for these applications. Students may only use one of the following for credit: 42-334/03-310, 03-311, 42-434/03-510 or 42-734/03-710. Prerequisites: (21-112 Calculus II OR 21-118 Calculus of Approximation) AND 03-121 Modern Biology AND (99-101 OR 99-102 OR 99-103 Computing Skills Workshop).

Prerequisites: 03-121

42-341 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 methods for the analysis of human motion are developed. Both analytic 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. Pre-requisites: 21-260

Differential Equations AND (24-262 Stress Analysis OR 12-331 Solid Mechanics OR equivalent). Useful, but not required: 24-141 Statics and Dynamics AND 24-202 Mechanics of Deformable Solids.

Prerequisites: 21-260 and 24-262

42-377 Rehabilitation Engineering

Fall: 12 units

Rehabilitation engineering involves the application of engineering sciences to design, develop, adapt, and apply assistive technologies to problems confronted by individuals with disabilities in functional areas, such as mobility, communications, hearing, vision, and cognition, and in activities associated with employment, independent living, education, and integration into the community. It differs from classical biomedical engineering by its focus on improving the quality of people's lives, rather than improving their medical treatment.

This course will require participation in simulations of disabilities and projects to develop new technologies. No textbook is required.

Prerequisite: Physiology Prerequisite: Physiology

42-400 Senior BME Research Project

Fall and Spring

Research projects for seniors, under the direction of a regular or courtesy BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects at local hospitals provided that a regular or courtesy 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 one-page project description with sign-off by the research advisor and a copy submitted for review and filing to the student's academic advisor. 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.

42-401 Foundation of BME Design

Fall: 3 units

42-401 Foundations of Biomedical Engineering Design (Fall, 3 units) (Precursor to 42-402) 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

42-402 BME Design Project

Spring: 9 units

42-402 Biomedical Engineering Design Project (9 units, Spring) 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

Prerequisites: 42-401

42-413 Biomaterial Interfaces

Intermittent: 12 units

The topic for this spring's course will be Fundamentals and Applications of Surfactants and Macromolecules at Interfaces. We will talk about the interfacial physical chemistry of surfactants, synthetic polymers and biopolymers including proteins and DNA. Applications will be drawn from materials technology, pharmaceutical processing, and biotechnology. Students are welcome to take this course for credit or to sign up as an auditor. The latter choice might be suitable for those who have satisfied their course requirements but are interested in learning more about complex fluids or biointerfacial phenomena.

Prerequisites: 42-202

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 throughput screening; microfluidic and microarray device design principles and fabrication technologies; molecular motors. Prerequisites: 03-231 OR 03-232 Biochemistry. Prerequisites: 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 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. Prerequisites: 18-396 Signals and Systems or permission of the instructor. Cross-listed courses: 18-496 Prerequisites: 18-396 and 42-202

42-434 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 only use one of the following for credit: 42-334/03-310, 03-311, 42-434/03-510 or 42-734/03-710. Pre-requisites: 03-121 Modern Biology and (15-200 Advanced Programming or 15-211 Fundamental Data Structures and Algorithms). Prerequisites: 03-121

42-441 Cardiovascular Biomechanics

Fall: 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

Spring: 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, 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 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. Prerequisites: Junior or Senior Status. (Renumbered from 42-644)

42-447 Rehabilitation Engineering

Fall: 9 units

Rehabilitation Engineering involves the application of engineering sciences to design, develop, adapt and apply assistive technologies to problems confronted by individuals with disabilities in functional areas, such as mobility, communications, hearing, vision, and cognition, and in activities associated with employment, independent living, education, and integration into the community. It differs from classical biomedical engineering by its focus on improving the quality of people's lives, rather than improving their medical treatment. Unlike most other engineering courses, we will also consider what makes some devices successful in assisting people with disabilities,

while other - apparently superior - engineering designs fail. This course will require participation in simulations of disabilities and class presentations/projects to spotlight emerging technologies. Prerequisite: None, but 42-202 Physiology is useful. Sophomore students require permission of instructor.

42-509 Special Topics

Spring: 9 units

42-509 Special Topics: 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

42-511 Biomaterials

Spring: 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 biological response. Cellular interactions with various surfaces and immunological responses will also be covered. Applications of biomaterials to be discussed include tissue engineering, artificial implants and devices. Part I of this course is offered in the Spring and focuses on the principles, properties and applications of polymers as biomaterials. Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful. Also known as 27-511.

42-560 Undergraduate Projects

Fall and Spring

Students elect to do a Biomedical Engineering project for credit either with a CMU faculty member, a faculty member of the University of Pittsburgh School of Medicine, or researcher at a hospital. If the student does a project off-campus, the student must have a Carnegie Mellon faculty member co-advising the project. Arrangements are made with Hilda Diamond, Associate Director. Units vary from 9 units to 12 units.

42-590 Special Topics in Signal Processing:

Spring: 12 units

The brain is among the most complex systems ever studied. Underlying the brain's ability to process sensory information and drive motor actions is a network of 10^{11} neurons, each making 10^3 connections with other neurons. Modern statistical and machine learning tools are needed to interpret the plethora of neural data being collected, both for (1) furthering our understanding of how the brain works, and (2) designing biomedical devices that interface with the brain. This course will cover a range of statistical methods and their application to neural data analysis. The statistical topics include latent variable models, dynamical systems, point processes, dimensionality reduction, Bayesian inference, and spectral analysis. The neuroscience applications include neural decoding, firing rate estimation, neural system characterization, sensorimotor control, spike sorting, and field potential analysis. Prerequisites: 18-290; 36-217, or equivalent introductory probability theory and random variables course; an introductory linear algebra course; senior or graduate standing. No prior knowledge of neuroscience is needed.

42-620 Engineering Molecular Cell Biology

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 nano-technology. 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 biotech 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: 42-621/06-621 Biotechnology and Environmental Processes or permission of instructor. Useful, but not required, background in 03-231 Biochemistry I.

42-624 Biological Transport

Spring: 9 units

Analysis of transport phenomena in life processes on the molecular, cellular, organ and organism levels. Material covered: Fick's Laws; electrolyte diffusion; coupled diffusion and chemical reaction; membrane transport mechanisms; osmosis; Donnan equilibrium; receptor-mediated binding; ultrafiltration and nephron function; blood flow; pharmacokinetic modeling. Pre-requisites: 06-262 Mathematical Methods of Chemical Engineering or 21-260 Differential Equations.

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 introduced are applied to examples of multi-scale biomodeling and simulations at the molecular, cellular, tissue, and organ level scales.

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, motility, and adhesion; (2) the generation of force and motion by motor molecules; (3) stretch-activated ion channels; (4) protein and DNA deformation; (5) mechanochemical 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 on the biomechanics issues at the cellular and molecular levels; their clinical and engineering implications are elucidated. 3 hrs. lec. Prerequisite: Instructor permission. Prerequisites: None. Corequisites: None. Cross Listed Courses: 24-655 Notes: None. Reservations:

42-646 Molecular Biomechanics

Intermittent: 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 nano-scale, 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.

42-652 Introduction to Biomechanics

Spring: 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 methods for the analysis of human motion are developed. Both analytic 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. Prerequisites: 21-260 Differential Equations; 24-263 Mechanics of Materials OR permission of instructor. Useful, but not required: 24-141 Statics and Dynamics and 24-202 Mechanics of Deformable Solids. Course offered if a minimum of students sign up for the course. Prerequisites: 21-260

42-660 Surgery for Engineers

Fall and Spring: 9 units

This course explores the impact of engineering on surgery. Students will interact with clinical practitioners and investigate the technological challenges that face these practitioners. In addition to weekly seminars, 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. 1. Clinical Neuroscience Practicum involves on-site experiences with a variety of neuroscience faculty: neurosurgeons, neurologists, neuro-interventionalists, neuro-radiologists, clinical neuro-physiologists, neuro-otologists and neuro-ophthalmologists. Direct contact will be at least 3 hours a week. 2. Clinical Cardiovascular Practicum involves on-site experiences with cardiology and cardiovascular surgery faculty: cardiac surgeons, thoracic surgeons, cardiologists, interventional cardiologists, cardiac perfusionists, and cardiac radiologists. Direct contact will be at least 3 hours a week. 3. Clinical Orthopedic Practicum This practicum involves on-site experiences with orthopedic faculty: shoulder surgeons, hip surgeons, knee surgeons, hand surgeons, sports medicine surgeons, and physiatrists. Direct contact will be at least 3 hours a week. The final report of the practicums will involve the most interesting, innovative, important problem uncovered which in the view of the team can be solved with a technology or a significant optimization of a technology. The report form will be the NIH R21. Opportunities to collaborate with engineering students from an outside institution will be sought. Pre-requisite: Physiology 42-202.

Minors Offered by the College of Fine Arts

48-095 Architecture for Non-Majors 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 surface 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.

Prerequisites: 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.

Prerequisites: 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 Wiley 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 Nicolaides 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.

Prerequisites: 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.

Prerequisites: 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 analogue 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: (21-114 or 21-120) and (48-115 or 33-106)

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, sitecast 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

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.

Prerequisites: 64-100 or 79-104

48-300 Architecture Design Studio: Site

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 enquiries 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.

Prerequisites: 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 or 48-115

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.

Prerequisites: 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.

Prerequisites: 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 theoreticians 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.

Prerequisites: 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 national trends in American architectural and urban design between circa 1850 and 1950.

Prerequisites: 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 through 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 pigeon-hole (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.

Prerequisites: 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.

Prerequisites: 48-240

48-348 History of Central American Architecture

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.

Prerequisites: 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 cataclysm 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.

Prerequisites: 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.

Prerequisites: 48-205

48-352 A History of Preservation: Debate, Theories and Practices

Intermittent: 9 units

The 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 features of modern-day approaches and problematic aspects, 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.

Prerequisites: 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 Nicolaïdes. It aligns with the transactionalist understanding of perception and considers perspective as partly 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 3-4 weeks duration each.

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 Constantinople/Istanbul, 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 the 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.

Prerequisites: 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.

Prerequisites: 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 a 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.

Prerequisites: 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: Lighting

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. Prerequisites: 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). Topics include a review of physiological and psychological response to the acoustical environment, predictions of outdoor and indoor air-borne sound propagation, sound transmission between rooms, design methods in room acoustics, and applications of computer-aided simulation tools for room acoustical design.

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. Prerequisites: 48-305

48-420 City as Landscape: Geography as Method and Metaphor

Intermittent: 9 units

This seminar course will explore the emergence of geography as a guiding method and metaphor in recent architecture, landscape and urban design discourse and practice. In the beginning of the twenty-first century it has become clear that the form of urban settlement is driven by complex interacting systems, ecologies and economies. With the rise of globalization and post-fordist economics, the city as landscape is required to function socio-economically at the scale of region and globe, ecologically at the scale of region and watershed, and socio-politically at the scale of community and municipality. In this situation designers are increasingly confronted with complex layered problems affecting territorial scales, and as a result advanced design has looked to other disciplines, adopting geographic strategies for both analysis and formal articulation. This course will explore design's emergent geographic approach through readings, project case studies and finally with a speculative analysis and design proposal. We will examine both the key texts and projects of this emerging landscape urbanism with the thesis that the base paradigm is that of geography. In addition we will also explore texts on landscape ecology and cultural and urban geography to expand our analysis of the roles and territories that the contemporary city is expected to serve. Through the readings and project examples we will search for ways in which the use of geography and landscape can be integrated to create an urbanism capable of addressing social, economic, political and ecological issues. The project for the course will be a series of cumulative assignments to analyze and propose conceptual interventions to a site related to, but not necessarily in, the Pittsburgh region.

48-431 Bio Logic Responsive Building Technology

Intermittent: 9 units

In an effort to better understand the porous boundaries between living and non-living systems we will look to nature as a model network of interactive systems that produce no waste; we will observe that animals and plants have evolved a large variety of reliable and relatively simple mechanisms to adapt to environmental fluctuation; we will understand that the inherent complexity of the mechanisms is an emergent property based on simple rule sets. Specifically the team will 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 primary objective is to advance the potential of the building envelope to serve as a selective filter, a three-dimensional porous topography calibrated, through active or passive means, to store, transform or dissipate energy. We will apply our research to some of the immediate and relevant problems that face society today, either in the form of building retrofit or the design of new building prototypes. Prerequisites: 48-125

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, arid 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. Prerequisites: 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. Prerequisites: 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. Prerequisites: 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 esthetic 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, Pliny, Leon Battista Alberti, Thomas Cole, Frederic Law Olmsted, Buckminster Fuller, Reyner Banham, Ebenezer 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. Prerequisites: 48-240

48-452 Real Estate Design and Development

Fall: 9 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. Prerequisites: 48-305

48-453 Urban Design Methods

Fall: 9 units

Cities now accommodate over half of the world's population. They cover only 2% of the world's surface, yet they consume 75% of its resources. This course introduces the discipline and practice of urban design and provides a critical overview of the work of urban designers historically, and in today's context. Economic, political, social and cultural factors that have influenced urban typologies and city development will be explored, including diverse eastern and western attitudes towards the way the world is viewed and experienced, from the macro-scale of urban planning and design to the micro-scale of the human body, social relations and self organization. Issues such as increasing population growth, human migration patterns, sustainable urbanism, and the role architects, urban designers and planners can play will be discussed. Lectures, weekly readings, a group fieldwork assignment, and correlating student presentations will introduce key urban design projects and methods from the region and across the globe.

Corequisite: 48-500

48-470 Experimenting with Lamination, Clamping, and Cutting

Fall: 6 units

The 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.

Prerequisites: 48-105

48-473 Hand and Machine Joinery, New Directions

Fall: 6 units

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.

Prerequisites: 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/>

48-497 Thesis I

6 units

48-500 Architecture Design Studio: The Urban Laboratory

Fall: 18 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. Prerequisites: 48-405

48-505 Studio X

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 enquiry. *Students can also fulfill Studio X via a School of Architecture approved Study Abroad Experience.

Prerequisites: 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 counterpoint 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 detail in 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 Bell, 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 responsiveness 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.
Prerequisites: 48-125

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 speculates upon the potential found within combinations of standard materials. The material relationships will provide the framework to transform the traditional assumptions of a 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.
Prerequisites: 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 different 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.
Prerequisites: 48-105

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".

48-564 Furniture Design & Construction

Spring: 9 units

The projects for this course will consist of two functional objects. The first will last for 3 weeks and is designed to re-familiarize students who haven't used the shop recently to its machinery and standard processes. During its duration some traditional hand skills will also be introduced. This first project will challenge all students, including experienced users, to understand how process can generate form/pattern and the different character of these form/patterns. The students will be required to integrate these patterns into an interwoven expression. The second and major project will last the remainder of the semester. It will be a functional piece of furniture with specified design parameters. An assignment for studying an artifact or structure in the urban environment through sketching and photography and research will be issued. This study will become the starting point for the design of the object. Materials will be procured before mid semester. The project will be due, and a review will be scheduled during the final exam period at a good time for all participants.

Prerequisites: 48-105 and 48-470 and 48-473

48-568 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.
Prerequisites: 48-305

48-569 GIS/CAFM

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

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 typologies 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

In recent years a new generation of architects has emerged in London, a generation separate from the great High-Tech offices (Foster, Rogers, Hopkins, Grimshaw) and the cosmopolitan orbit of the Architectural Association in the 1970s (Koolhaas, Tschumi, Hadid, Coates). This new generation is intimately engaged with England's contemporary urban condition. In particular, these "Gritty Brits" operate in the East End of London, a context that is both post-industrial and home to many successful Young British Artists. If the Walsall Art Gallery by Adam Caruso and Peter St. John appears remarkably sober and tailored, Blue House by Fat is an instantaneous Pop icon. If Sergison Bates's Social Housing Prototype is a discreet re-presentation of the generic semi-detached house, urban design proposals by muf mix community memories with new modes of decoration. David Adjaye has built homes for successful artists (Tim Noble/Sue Webster) as well as Idea Stores, a reinterpretation of the traditional borough library. This course investigates certain key works in recent English architecture together with aspects of urbanisation and visual culture in contemporary London (music, literature, cinema, fashion). Also included is an appraisal of London culture in the 1950s when appreciation of The Everyday ranged from New Brutalist architecture and Kitchen Sink dramas to early Pop collages by Richard Hamilton.

Prerequisites: 48-105

48-587 Architecture Lighting Design

Intermittent: 9 units

Through hands-on exploration in the light lab, lecture and discussion, students will develop a design process for lighting people and architecture. Topics will include: Role of the architectural lighting designer in the collaboration process; Establishing design goals and a point of view; Communicating design ideas; Lighting interiors (retail, restaurants, offices, museums, hotels); Lighting exteriors (landscape, buildings, bridges); Technical tools (luminaires, lamps, control and dimming) A large part of class time will be devoted to hands-on experimentation of light. Students will also spend time in the light lab outside of class preparing realized lighting designs. The final design project will include full scale lighting mock-ups.

Prerequisites: 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-Francois 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.

Prerequisites: 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 Scofidio & Diller reference Marcel Duchamp, Rem Koolhaas and Herzog & deMeuron 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.

Prerequisites: 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 (LEEDTM) 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.

Prerequisites: 48-315

School of Design

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 will cover 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 social 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: 51-101

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 will be stressed. Students will be 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 and 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

402 Course Descriptions

reinforce freehand sketching and provide the basis for introduction to more complex drawing media. Demonstrations and group and individual critiques reinforce concepts presented in class. This course is for undergraduate design majors only.
Prerequisites: 51-121

51-132 Introduction to Photo Design

Spring: 4.5 units

Introduction to photography for designers through digital photography. 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 in the world we will see how photography is another means of image-making for designers who need to know how to read photographs as well as how to make them. In the shooting studio, students will learn basic documentation skills and how to make digital portfolios of their two-dimensional and three-dimensional work. In addition to making photographs, we will look at different kinds of existing photographic imagery, e.g. documentary, advertising, scientific, fine art-to gain an overview of the medium and learn how photographs effectively communicate information. Shooting assignments in and out of the studio, critiques, and library research. Required for all design majors; lab fee; digital camera necessary.
Prerequisites: 51-101

51-134 Photo Design II

Spring: 4.5 units

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 will 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 will consider the role of human beings in the design process, exploring how designers respond to human needs and issues of value. Finally, we will 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 is the first course in the Design Studies sequence of the department. Lectures, discussions, and written assignments, with readings and extensive visual materials. Required for all design majors.

51-201 Basic Typography Communication Design I

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 type as image serves to open a path for students to study all facets of communication design in subsequent courses. Students use both traditional materials and design tools as well as computers. Special tutorials provide basic instruction in software such as InDesign and Adobe Illustrator. In addition, we will also discuss some of the key figures, philosophies, and technologies that have shaped typography. The course will also include a demonstration of letterpress operation in the Design Department'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: 51-102

51-202 Intermediate Typography

Spring: 9 units

The theme of this course is the integration of type and image. The primary goal of the projects is how to achieve a harmonious and effective interplay of typography and imagery to express meaning. Through a confident use of grids, color, images, type, and visual hierarchy, students will explore a variety of solutions to design problems that require both expressiveness as well as an understanding of the practical uses of communication design. With an emphasis on formal and semantic issues, assignments will demonstrate how typography, photography, and other forms of image making may be combined to shape the form and content of communication. This course is for undergraduate Communication Design majors only.
Prerequisites: 51-201

51-203 Communication Design Computer Lab

Fall: 3 units

This sophomore level Communication Design course introduces students to the software required to generate communication design pieces. Software will be introduced in a way that coincides with the Basic Typography assignments. CD majors only, or permission of the instructor.

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.
Prerequisites: 51-102

51-212 Meaning of Forms: ID Studio II

Spring: 9 units

This studio course introduces students to semantic and symbolic aspects of industrial design. Several projects are given and students are required to develop studies that express the functional and cultural meanings of products. Students use various methods of conceptual sketching, detailed documentation, and prototyping; lab fee. Due to space constraints, this course is only offered to undergraduate Industrial Design majors.
Prerequisites: 51-211

51-222 Color and Communication

Spring: 9 units

As a communication tool, color can signal, enhance, and speak in ways that type and images cannot. Combined with type and images, color can contribute to the persuasive and communicative force of design. Beginning with a perceptual understanding of color, this course will explore the many ways that color communicates. 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 Production for Designers, From Pixels to Print

Spring: 9 units

A lecture/lab exploration of the processes and materials of the printing industry as they support and condition the work of the communication designer. The role of electronic publishing tools in the preparation of finished art will be emphasized. Field trips to a printer and an electronic pre-press facility, as well as guest lectures from industry, keep this course up-to-date; lab fee. This course is for undergraduate Communication Design majors only, or by permission of the instructor.
Prerequisites: 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

This course is a Communication Design sophomore requirement. Students will explore conventional and digital means of image making. Students will gain in-depth exposure to digital manipulation through Adobe Photoshop as well as developing skill sets concerning digital input and output. The techniques learned will facilitate students' delivery of content in their images. Instructor permission required for non CD sophomores.

51-231 Calligraphy I

All Semesters: 9 units

Working with pure unadorned Roman letterforms, this course will introduce the student 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 will be taught through weekly projects. Awareness of rhythm, texture and letterform structure are achieved through routine exercises. Drills, demonstrations, discussions, individual and class critiques are on-going. Additional related topics and activities introduced in class include Books: binding and design. Brief introduction to the historical development of our Western alphabet through film, slides, demonstrations, with discussion of twentieth-century type designs. Letter vocabulary, paleography, monoprints, words and punctuation. Classical page design. Publications past and present. 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

Continuation of Introduction to Calligraphy I. Advanced problems in calligraphy and lettering. New hands are introduced, to be decided by student and instructor.

Prerequisites: 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. Due to space constraints this course is for undergraduate Design majors 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.

Prerequisites: 51-211

51-243 Prototyping

Fall: 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. This course is for ID majors only.

51-246 Photo Documentation

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.

Prerequisites: 51-211

51-251 Digital Prototyping

Fall: 4.5 units

A half-semester laboratory mini-course introducing 3D modeling software. Course Structure Each class meeting will consist of an introduction to and demonstration of specific aspects and functions of SolidWorks. 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.

51-261 Communication Design Fundamentals

Fall: 9 units

A one-semester course that introduces non-majors to the field of communication design. Through studio projects, lectures, and demonstrations, students become familiar with the visual and verbal language of communication designers, the design process, and the communicative value of world and image. Macintosh proficiency required. This course is required for HCI double majors and Design minors. All students must visit the design office in MM 110 during registration week, and fill out a form to request a seat in this course. Section W - Qatar campus only

51-262 Communication Design Fundamentals

Spring: 9 units

A one-semester course that introduces non-majors to the field of communication design. Through studio projects, lectures, and demonstrations, students become familiar with the visual and verbal language of communication designers, the design process, and the communicative value of world and image. Macintosh proficiency required. Because of the heavy demand for this course, students must visit the Design office in MM 110, and fill out a form requesting a seat in this course, during registration week.

51-263 Industrial Design Fundamentals

Fall: 9 units

A one-semester course that introduces non-majors to product development from the industrial designer's point of view. Through studio projects, lectures, and discussions, students will gain experience in visualizing a product for mass production. Case histories and the analysis of existing products will supplement hands-on experience in developing product concepts. This course is required for all ID minors.

51-265 Black and White Photography I

Fall: 6 units

Introduction to the methods and practices of black and white photography, including darkroom practices. 35mm camera required; lab fee.

51-271 Design History I

Fall: 9 units

This course provides an overview of design history from 1850 to 1950, the critical period for the formation and development of design and the design professions. There are three primary goals. The first is to provide an understanding of the role that design has played in the evolution of the competitive free market system at national and global levels. The second goal is to demonstrate how design emerged as a powerful tool for corporate and cultural identity in this period. The third goal is to develop an understanding of some of the basic influences on the formation of design theory and practice in the twentieth century. This is accomplished through the presentation and discussion of primary economic and cultural forces, philosophical ideas, artistic and social movements, and significant individuals and artifacts that represent the period. The course traces both the chronological and the contextual development of design, providing students with an understanding of design as an evolving concept. This course is required for Design majors and Design minors.

51-272 Design History II

Spring: 9 units

This course focuses on the development of design from 1950 to the present, with further exploration of the themes introduced in Design History I as well as the introduction of new themes that have emerged to influence the direction of design thinking. The themes range from design for communities, to personal visions of individual designers, to the needs and expectations of society. The course explores the relationship between design and gender, race, the environment, political systems and social change. Students develop an in-depth understanding of these themes through lecture, research and presentations. This course is open to Design majors, BHA Design students, Design Minors, and by permission of the instructor.

51-274 Design and Social Change

Spring: 9 units

In this course we will examine the important relationships of history, culture, policies and the environment in communication design and industrial design. Conversely we will study the ways in which design can affect our culture and environment, both positively and negatively. Topics include: sustainability, universal design, system thinking and system visualization. While various cultures will be acknowledged and discussed, the major emphasis will be on Western culture. Through lectures, videos, reading and projects, students will develop their ability to incorporate historical context and consideration of potential consequences into their design process.

51-301 Advanced Typography CD III

Fall: 9 units

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-CD majors.
Prerequisites: 51-202

51-302 Typography IV

Spring: 9 units

The world is complex, and we have made it so. This course is a creative venture that deals with complexity, in particular the complexity of visual information that surrounds us in our daily lives. From train schedules to tax forms to the user guide for a VCR, humans have created a typographic labyrinth within which we are often lost. This course deals with the basic principle that communication designers employ when they represent complex information, making it visible and accessible. Assignments are specific, but their lessons are fundamental, providing students with conceptual and visual tools that will help to solve any information design problem. Instructor permission required for non-CD majors.
Prerequisites: 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 a digital camera are 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: 9 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 they catch the light differently? Does the sunlight come into the space, casting shadows? Or is the light primarily artificial, 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: 4.5 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 two series of photographs: one that is fiction and one that is non-fiction. In addition to making photographs, students will determine the context in which their photo-stories will be seen. Students may make photo books, for example, or decide that their images will be seen on a website. While students are making photographs, we will explore the rich traditions of photo-graphic 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 constructed private worlds, such as Duane Michals, 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. 12-15 students Prerequisite—a college level photography course.
Prerequisites: 51-221 and 51-221

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
Prerequisites: 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: 51-122

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.
Prerequisites: 51-202

51-326 Documenting the Visual

Intermittent: 9 units

A critical look at documentary photography. We will examine 19th and especially 20th century images to see how photographers have shaped and extended a tradition that continues into the present. We will discuss theoretical issues?e.g. how cultural context influences the making and understanding of photographs; how photographers use both conscious as well as unconscious strategies in image-making; how documentary images take different forms-ranging from

seemingly literal and objective descriptions, to intensely personal statements, to images coupled with text. In exploring these issues, we will look at a variety of image-types: family and candid photos, company and advertising photos, political and humanistic or social photo-essays. Extensive visual materials, readings, written and optional photo assignments. Intended for students majoring in the Department of Design or the Department of English, or by permission of the instructor.

51-327 Introduction to Web Design

Fall: 9 units

This class will introduce the basics of setting up a web site, as well as the fundamentals of XHTML, CSS, and Flash to assist students in creating semantically correct web pages that can be viewed across a variety of platforms and browsers. The class will also help students understand the constraints and advantages of working with the web as compared to traditional print media. 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: Photoshop, Illustrator, Dreamweaver, Flash. This course is for Design Majors only, or by special permission of the instructor.

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

Continued study in the discipline of calligraphy. (Meets with Introduction to Calligraphy I.) Two directions may be taken. (1) Enlarging the student's repertoire of scripts, contemporary or traditional, for use in limited areas of work such as book or display work. (2) Concentrating on more intensive problem solving using a limited repertoire of scripts such as Roman, Italic, Sans Serif. Prerequisites: 51-232

51-332 Advanced Calligraphy II

All Semesters: 9 units

Continued study in the discipline of calligraphy. (Meets with Introduction to Calligraphy II.) Advanced problems or new direction determined by student and instructor. Prerequisites: 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 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 Diagraming

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.

Prerequisites: 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 form of reproducing the printed 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 many major nineteenth and 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 subject; the reasons for making documentary photographs; the intended audience for documentary photography; and the appropriate final display of the photographs?should they be on museum walls, are they effective as printed pieces, and are they accessible to and/or have the approval of the subject? 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

ID 51-343: Digitech Tools 1. 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. PreReq = 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: 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. Prerequisites: 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 other' they are organized in order to build upon each other.

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.

Prerequisites: 51-311

51-349 Visual Notation

Intermittent: 4.5 units

Visual Notation, Journal 51-349 A1 1st mini This course is about keeping a daily visual journal. The importance of its use will be placed on ways of seeing, ordering, discovering and making relationships while involved in the process of visualizing, exploring and recording. We will use a variety of drawing media; some that may be new to you and through experimentation we'll look at the impact media has on your image making process. We will examine a variety of subjects both man made and natural, large and small. One major goal of the course is to have you see the journal as not just a compilation of notations but as a comprehensive tool for visual thought and expression. We will also examine journals done by a variety of designers, architects and artists and discuss how making visual assessments condition the way we think and see the world. Consistent with the credits given for this courses a total of 5-6 hours of work, both in and out of class will be expected each week. Your journal will be turned in for evaluation the last day of class. Instructor permission required for non-Design majors.

51-350 Visualization

Intermittent: 9 units

Visualization This course introduces methodologies for visualizing, recording and presenting ideas. With an emphasis on creating visual narratives, students will 1. engage in activities of field notation, journaling, storyboarding, and hot-house conceptualization; 2. gain exposure to advanced rendering techniques using markers, chalk pastels, and adobe illustrator/photoshop; 3. appreciate the qualities and differences of idea, concept and presentation sketching; and 4. integrate these methodologies of visualization to develop a flexible structure for their design portfolios to communicate their body of work in a public forum. Roughly 8 weeks will be devoted to developing, drawing and illustrating ideas with the remainder of the semester focusing on presenting these ideas through portfolio construction. Instructor permission required for non-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 draftsmanship 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.

51-353 Writing & Photography: Magazine Writing & Journalism

Intermittent: 9 units

Revealing Place: Photographers and Writers Working Together Writers and photographers have worked together throughout the 20th and into the 21st 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

51-371 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 courthouse 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 From Drawings to Photographs

Intermittent: 9 units

Images abound in our culture. This course takes a critical look at many different kinds of visual images to understand how they operate in our culture to inform, persuade, and entertain various audiences. In the first half of the semester we will look at wide range of primarily hand-generated and digital images; in the second part of the semester we will specifically look at photographs. 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 drawings in museums, to images that are used in scientific representation, to snapshots in family photo albums. Readings will be assigned and short writing exercises will be required throughout the semester. In addition, photography assignments will be given in the second part of the semester. Design majors only, or by permission of the instructors. Requirement: a digital camera. 14 students, junior and seniors

51-376 Aesthetics and Design

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

peoples' 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 necessitate 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 Mid-Century Modern: Topics in Design History

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 Conceptual Models

Intermittent: 4.5 units

Conceptual Models and Design Implications The challenge in human-centered design is not in conducting appropriate research, but in making the leap from research findings to design implications. Creating a model is often an important step toward creating consensus or a driving concept when working with multidisciplinary development teams. In this mini we will focus on one of the most challenging aspects of the design process. We will quickly develop a hunt statement, conduct discovery stage immersive research and use our findings to develop conceptual models and design implications. This course is open to upper level students in Design, HCI, BHA, engineering and graduate business students.

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 2 parts. During the first 1/3 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 2/3 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 Beyond the Snapshot - using Photography to see, to think, to feel

Intermittent: 4.5 units

Beyond the Snapshot —using photography to see, to think, to feel 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? 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 mini explores seeing with the camera and the many issues that arise when one snaps the shutter. In addition, we will be looking at a range of different kinds of photographic images and understanding how to read them. While we are making photographs, we will be discussing critical issues in photography that come out of significant readings by Susan Sontag, Roland Barthes, and others. We will break the course into three main subject categories—photographs of people; photographs of the social and man-made landscape; and photographs that are art driven. By using these subjects, students will become better seers in the world, more critical of images generally and of their own images; and, they will become more aware of the photography as an expressive medium. Prerequisite: A college level photography course : 15 students—junior to grad : Familiarity with digital photography and a digital camera —

51-394 Applied Research Methods

Intermittent: 9 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, make' 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 Systems Thinking and Design Action

Intermittent: 9 units

Systems Thinking & Design Action This seminar focuses on the innate, essential nature of designed things, designing and designers from a holistic or systemic perspective. Everything designed is part of a larger system(s). Nothing—people, artifacts, or activities—exists in a vacuum. Understanding the relationships and interrelationships of designed things is essential in today's complex and dynamic world. In addition, designed artifacts at any level of complexity or simplification are systems themselves or elements within systems. Designs therefore must be created or critiqued from a systemic perspective. Every designer works in an environment and context which effects and is effected by designing activity. It is therefore important to understand the systemic interactions of intentional design action within the dynamic milieu in which designing occurs. Designing is rationalized through systemic inquiry—systemics is the logic of design. Systemic analysis and synthesis—systems science—are essential aspects of design inquiry. Knowledge for design action is grounded in a systemic understanding of design thinking. These systemic design issues will be explored through readings, lectures and class dialogue.

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.

51-403 Senior Project: Interaction 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 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.

51-404 Senior Project: Interaction Design

Spring: 12 units

This is the spring offering of 51-403.

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 51-409

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.

51-414 Integrated Product Development

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 Introduction Computing in Design

Fall: 9 units

This digital studio/seminar course introduces fundamentals of computing that are important for designing digital media. Initially, basic concepts of the computing environment, such as display technologies, input/output devices, networks, and software, are introduced. Students are then introduced to various computational concepts through hands-on programming exercises. Recent programs include Java, Flash, and Action Script. No prior programming experience is required. Prerequisite: concurrent registration in Graduate Design Seminar I and Graduate Studio I or approval of instructor. This course also requires a laptop computer for completing in-class exercises.

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 card-boards. 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 image, in 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 card-boards. 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 image, in 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

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

All Semesters: 9 units

51-433 Advanced Interaction

Intermittent: 9 units

An interface is the link between a user and a product that communicates how a product will be used and creates an experience 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 activate vision, hearing and 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 a process for creating interface designs that can be reapplied in future contexts.

Prerequisites: 51-421

51-434 Experimental Form

Intermittent: 9 units

Experimental Form Studio This course looks at the way objects elicit emotional responses and play key roles in enhancing our daily lives. The 5 individual themed projects for the semester, found, formed, fabricated, fiber, and functional, incorporate various production processes with traditional and new (sustainable) materials, emphasize different form-making principles, and lead to artifacts whose forms richly communicate on both visual and deeper emotional levels. Artifacts generated in this course can be identified as sculptural objects or functional art and be highly graphic in their visual presentation. On the last day of the semester, we will open a 2 week long gallery show in 5 different locations on campus and in street-side window displays along Butler Street in the 16:62 Design Zone in Lawrenceville. Pre-requisite: Junior standing in ID. Limit: 15 students

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. 1985) I am looking to enter into a dialogue with undergraduate and graduate design students based on the notion of creating a persuasive argument to their design presentations. More importantly, 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 markets 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 case studies and evolve into team research on the 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.

Prerequisites: 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 proposal the area of furniture 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 workmanship in design, and on how the behavior of the user is influenced by the form or esthetic language of the artifact. Lab fee & material purchases required.

Prerequisites: 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 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 professions. 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.

School of Drama

54-011 Warmup

Fall: 1 unit

Drama majors only.

54-012 Warmup

Spring: 1 unit

Drama majors only

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.

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 open to Drama majors only. Prerequisites: 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.

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.

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: 6 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.

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

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: 3 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.

54-111 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. Prerequisites: 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. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 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. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-123 and Permission of instructor

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.

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.

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.

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.

54-162 Intro to Costume Design

Spring

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. Instructor permission and an interview/portfolio review required for admission into this course.

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. Prerequisites: 54-163

54-166 Introduction to Sound Design for Theatre

Spring

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. PRE-REQUISITE: 54-231 Design For The Stage

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. PRE-REQUISITE: 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. PRE-REQUISITE: 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

54-177 Foundations of Drama I

Fall: 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.

54-178 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.

Prerequisites: 54-177

54-184 Dramaturgy 2: History and Practice

Intermittent

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: 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, 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 works-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

Prerequisites: 54-187

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

Prerequisites: 54-187

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 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 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. By permission only.

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. By permission only.

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.

Prerequisites: 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.

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.

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

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 Permission of instructor

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 into the process of character development. The Neutral Mask work is immediately reinforced with applications to their scene work in Acting class.

Prerequisites: 54-107

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 physicality, 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: 54-108

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

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

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. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

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. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

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

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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

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.

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

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
Prerequisites: 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.

54-229 The Comfy Chair

Fall: 6 units

Required for all Sophomore Design and Production students. Bring tools.

54-230 Make-up for Designers

All Semesters: 6 units

PRE-REQUISITE: Declared Design/PTM focus in the School of Drama

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

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 Scene 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 Scene 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, 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 for second year (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 one full semester 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 semester is devoted entirely to comedy improv and culminates in an original comedy improv show in the UC lobby.

54-245 History of Clothing

Fall

FOR: All Students, Drama Students have priority This year-long course traces the development of garments of the Western World from Egypt to the beginning of the 20th Century. The shapes of the various elements are considered as well as the way they are worn, how they affect the body and the society from which they spring. A course that 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. Normally 6 units, a 4 unit option without research projects is available for non-majors. PRE-REQUISITES: None

54-246 History of Clothing

Spring

FOR: All Students, Drama Students have priority This year-long course traces the development of garments of the Western World from Egypt to the beginning of the 20th Century. The shapes of the various elements are considered as well as the way they are worn, how they affect the body and the society from which they spring. A course that 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. Normally 6 units, a 4 unit option without research projects is available for non-majors. PRE-REQUISITES: None

54-247 Dramaturgy 3:Adaptation

Intermittent: 9 units

54-249 Stagecraft II

Fall

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

54-250 Intro to Scene Design

Intermittent

An introduction to the principles and practices of designing scenery emphasizing the interpretation and development of ideas based on a text. Pre-requisites: Basic Design, Stagecraft I

54-252 Introduction to Lighting Design

Spring

Students explore the physical properties of light in various design applications and develop a process of storytelling that involves analysis, research, exploration, questioning, problem solving and implementation of a successful design product. Prerequisites: 54231 Prerequisites: 54-251

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: 12 units

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. Pre-requisites/Co-requisites: Introduction to Production or instructors permission.

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. Pre-requisites/Co-requisites: Introduction to Production or instructors permission. Prerequisites: 54-163 and 54-164

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 Sound Design I

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 soundscape design. PREREQUISITE: 54-166 Introduction To Sound Design for Theater, 54-231 Design For The Stage.

54-268 Sound Design I

Spring

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 soundscape design. recording techniques, field recording, and mixing. PREREQUISITE: 54267 Sound Design 1 Prerequisites: 54252

54-269 Studiocrraft 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/Dreamweaver

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 theatrical 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.

54-271 Technical Management

Fall: 5 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

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 three semesters 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: 54-271 and 54-279

54-277 Stage Management I

Fall: 6 units

This class expands on the fall semester through a series of hands-on exercises and production experiences. Students refine skills in cue-calling and managing productions, and will work with other populations on collaborative projects.

54-278 Stage Management I

Spring

This class 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.

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.

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; 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.

54-292 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; 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.

54-294 Make-Up for Performers

Spring: 2 units

MAKE UP FOR ACTORS PRE-REQUISITES: School of Drama Student FOR: School of Drama Students with priority given to Actors and Costume Design majors **DESCRIPTION:** Basic techniques of stage make-up and their adaptation to theatrical styles. **MAKE UP FOR DESIGNERS PRE-REQUISITES:** Declared major in Costume Design FOR: Graduate and Undergraduate Costume Design majors **DESCRIPTION:** This course teaches designers the basic approach and processes used in designing makeup for theatrical production. It covers techniques of stage make-up application and the adaptation of theatrical styles as related to design.

54-299 Dramaturgy Production I

Fall

Prerequisites: 54-189

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, Moliere 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, Moliere 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: 54-301

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.

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.

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.

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.

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.

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.

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.

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 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.

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

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

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

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: 54-315 and Permission of instructor

54-317 Singing for Actors III

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. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

54-318 Singing for Actors III

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. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

Prerequisites: 54-207 and 54-208

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.

Prerequisites: 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.

54-322 Directing III: Forms and Formats

Spring

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

Prerequisites: 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

54-326 Actor Dance III

Spring: 3 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

54-330 Introduction to Stage Management

Spring

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 Scene Design I

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 Scene Design I

Spring

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.

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

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 Scene Painting II

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'oeil, 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 and 54-238

54-338 Advanced Scene Painting

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: translucency, tromp 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. Prerequisites: 54-245 and 54-347

54-342 Costume Design I

Spring

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: Sophomores 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. PRE-REQUISITES:None

54-344 Costume Construction I

Spring

FOR: Sophomores 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. PRE-REQUISITES:None

54-346 Introduction to Costume Construction

Spring

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

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: 6 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. Prerequisites: 54-351 Corequisites: 54-349
 Prerequisites: 54-349

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: 54-252
 Prerequisites: 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.

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.
 Prerequisites: 54-353

54-355 30 Hour Osha

Fall: 6 units

54-356 Stage Management II

Fall: 6 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 II

Fall: 6 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
 Prerequisites: 54-259 and 54-262

54-362 Production Preparation III

Spring: 12 units
 Prerequisites: 54-259 and 54-262

54-363 Dramaturgy 5: Devised and Documentary Theatre

All Semesters: 9 units

54-364 Dramaturgy 6:Advanced Topics

Intermittent: 9 units

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.
 Prerequisites: 54-366 and 54-378

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.

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.
 Prerequisites: 54-251 and 54-252

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.
 Prerequisites: 54-252
 Prerequisites: 54-251

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. Discreet 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: 6 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.
 Prerequisites: 54-163 and 54-164

54-378 Technical Design I

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
 Prerequisites: 54-273

54-379 2-d Scene 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, 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.

54-381 History of Drama

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 Scene Design Skills 3D

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.

54-387 Dramaturgy : Production II

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 III

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 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. s.

54-390 Growing Theatre Community Outreach

Spring: 9 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. s.

54-393 My True Voice

Fall: 9 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 Sound Design II

Fall: 9 units

54-398 Sound Design II

Spring

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.

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 T.V. techniques. Preparation for a New York presentation at the end of the Spring semester.

54-403 Voice and Speech IV

Fall: 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.

54-404 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 — 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.

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 rare chance for students to experiment with actor-created theatre, as well as, because it is cross-option, an 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: 54-307 and 54-308

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.

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 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.

54-410 Theatre Lab for Undergraduates

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 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.

54-411 Acting Symposium IV

Fall: 20 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.

54-412 Acting Symposium IV

Spring: 20 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.

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.

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.

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

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

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 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: 54-423 and Permission of instructor

Prerequisites: 54-423

54-431 Scenography

Fall

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

Prerequisites: 54-331

54-432 Scenography

Spring

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.

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.

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

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: 54-246 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

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 Business Practices for Designers

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 live 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 live 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

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.

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.

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: 15 units

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 Business Practices

Spring: 3 units

54-466 Machine Design II

Spring: 9 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: 54-665

54-469 Dance Lighting Design

Fall: 2 units

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.
Prerequisites: 54-378

54-478 Television Lighting Design

Fall: 1 unit

54-480 Technical Direction IV

Spring

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.

54-487 Dramaturgy: Production III

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 III

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: 6 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 seasons, 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.

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 seasons, 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

54-500 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: 2 units

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). Prerequisites: School of Drama sound design majors or minors only.

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: 54-666 Production Audio

54-511 Millinery I

Fall: 6 units

424 Course Descriptions

Costume Crafts I: Fabric Dyeing and Painting For: First Year Costume Design Graduate students. Graduate and Declared Undergraduate Costume Design Students will have priority for remaining spaces in the class. Students will learn the technique of fabric dyeing and painting using a variety of methods, chemicals, products, and processes. Students will gain facility in the use of the equipment and machinery involved, as well as developing stronger skills in color theory. Safe use and practices will be covered to instill good habits.

54-517 Director's Colloquium

Fall: 1 unit

54-518 Director's Colloquium

Spring: 1 unit

54-519 Acting for the Camera

9 units

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.

School of Music

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.

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.

Prerequisites: 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.

57-150 Basic Harmony II

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.

Prerequisites: 57-149

57-151 Concept and Practice of Counterpoint

Fall: 6 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 through the late twentieth-century. The second half examines, across several musical styles, specific contrapuntal techniques such as imitation and ground bass forms. Assignments include both writing exercises and analysis projects.

Prerequisites: 57-149 or 57-152 or 57-155

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.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 57-185

57-188 Repertoire and Listening for Musicians

Fall: 1 unit

This course is the required co-requisite listening component for Survey of Western Music History (57-173). In this course, students listen critically to essential music which has stood the test of time and to superior performances. It features 2-3 hours of listening per week. Corequisite: 57-173

57-189 Repertoire and Listening for Musicians I

Fall: 3 units

One of the most important ways of achieving musical excellence is to listen. In this course, students listen critically to essential music which has stood the test of time and to superior performances. 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 freshman music majors.

57-190 Repertoire and Listening for Musicians II

Spring: 3 units

One of the most important ways of achieving musical excellence is to listen. In this course, students listen critically to essential music which has stood the test of time and to superior performances. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. This semester introduces full scores for chamber and orchestral music. Midterm and final listening tests. This course contains midterm and final listening tests. Proficiency requirement for freshman music majors. Other students admitted with instructor's permission.

57-191 Keyboard Studies

Fall and Spring: 3 units

All undergraduate music students are required to take four semesters of keyboard studies during their freshman and sophomore years. The emphasis of this course is to develop a practical keyboard facility, which includes keyboard theory and technique, sightreading, solo and ensemble repertoire, transposition, and a variety of creative activities such as harmonization and improvisation.

57-193 Skills of Accompanying I

Fall: 3 units

A required course for first year piano majors. The skills include sightreading, basic keyboard harmony, transposition, and improvised accompaniments for popular or musical theater songs from either a piano reduction or a lead sheet. The students participate in collaborative situations such as juries, recitals, and class presentations. The presentations are critiqued by the instructor and by other students.

57-194 Skills of Accompanying II

Spring: 3 units

Continues 57-193 Skills of Accompanying I.
Prerequisites: 57-193

57-209 The Beatles

Intermittent: 9 units

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.

Prerequisites: 57-112

57-212 Movement and Dance IV

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.

Prerequisites: 57-211

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.

Prerequisites: 57-234

57-240 Acting I

Fall: 6 units

The basics of acting will be established throughout the first year following the guideposts described in *Audition*, by Michael Shurtleffs. Structured improvisations, monologues, scene work, songs, and arias will provide a platform for the development of stage presence and effective communication. Each semester will finish with a group project that provides an opportunity for the students to begin to work together as a cast.

57-241 Acting II

Spring: 6 units

Continues 57-240 Acting I.

Prerequisites: 57-240

57-257 Orchestration I

Fall: 6 units

This is an introductory course for all music majors and required for sophomore composition majors. The characteristics of each instrument of the orchestra are studied thoroughly. Orchestral textures from the classics to contemporary music are studied and analyzed.

Prerequisites: 57-149 or 57-152 or 57-155

57-258 20th-21st Century Techniques

Spring: 6 units

This course is open to all music majors and required for sophomore composition majors. The most important techniques from Debussy to the present will be reviewed in terms of melody, harmony, and form. Tonality, serialism, and aleatoric devices will be studied. Compositional techniques of the 20th Century are put into perspective and compared with other developments in the arts. The class is conducted as an open forum in which discussions are encouraged.

Prerequisites: 57-151

Corequisite: 57-408

57-271 Orchestration II

Fall: 6 units

This course is designed for junior composition majors; others are admitted by permission. The students will analyze music from the Classical to Avant-Garde and use the knowledge acquired to orchestrate piano scores in the appropriate style. Style, practicality, color, and imagination are encouraged.

Prerequisites: 57-257

57-273 Piano Pedagogy I

Fall: 6 units

This course offers an historical overview of piano pedagogy including its significant developments over the past forty years. Topics covered include beginning piano techniques, the sequencing of concepts and materials, common problems among beginning pianists, practicing, motivation, and parental involvement. Current representative beginning piano methods will be surveyed.

57-274 Piano Pedagogy II

Spring: 6 units

Beyond the beginning years: this course covers piano pedagogy of intermediate and early advanced level students. Topics include "What is a good piece?" Standard literature and technical development repertoire lists will be studied. The business of piano teaching and the instruction of college keyboard skills for non-piano majors will be discussed.

Prerequisites: 57-273

57-275 Piano Pedagogy III

Fall: 6 units

Continuation of 57-274. Intermediate literature, analysis, teaching, and performance will be covered. Topics include "What is style?"

Prerequisites: 57-274

57-276 Piano Pedagogy IV

Spring: 6 units

Continuation of 57-275. Early advanced literature, analysis, teaching, and performance will be covered.

Prerequisites: 57-275

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.

Prerequisites: 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.

Prerequisites: 57-283

Corequisite: 57-290

57-289 Repertoire and Listening for Musicians III

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 IV

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 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. Prerequisites: 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. Prerequisites: 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.

Prerequisites: 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.

Corequisite: 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.

Corequisite: 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.

Prerequisites: 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.
Prerequisites: 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.
Prerequisites: 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 recording 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 Pro-Tools 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 a 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.
Prerequisites: 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. The semester will close with a classical text project in which the students will work with verse.
Prerequisites: 57-241

57-340 Acting IV

Spring: 6 units

Continues 57-339 Acting III.

Prerequisites: 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 program at Carnegie Mellon University or who have demonstrated theory competence. The students will attend all sessions of the assigned 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.
Prerequisites: 57-350

57-352 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.
Prerequisites: 57-351

57-353 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.
Prerequisites: 57-352

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 57-336 and 57-356 and 57-360 and 57-361 and 57-362 and 57-363 and 57-375 and 57-607
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 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 eurhythmic, 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.

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.

Prerequisites: 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.

Prerequisites: 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 Accompanying I

Fall and Spring

This class 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.

57-382 Accompanying II

Fall and Spring

Continues 57-381 Accompanying I.

Prerequisites: 57-381

57-383 Accompanying III

Fall and Spring

Continues 57-382 Accompanying II.

Prerequisites: 57-382

57-384 Accompanying IV

Fall and Spring

Continues 57-383 Accompanying III.

Prerequisites: 57-383

57-385 Accompanying V

Fall and Spring

Continues 57-384 Accompanying IV.

Prerequisites: 57-384

57-386 Accompanying VI

Fall and Spring

Continues 57-385 Accompanying V.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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.

57-408 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.

Prerequisites: 57-150 or 57-153 or 57-156

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 Tales 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 notion 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).

57-414 Music and Nature

Intermittent: 9 units

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.

Corequisites: 57-500, 57-501, 57-502, 57-509, 57-521, 57-522

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.

Corequisites: 57-501, 57-502, 57-503, 57-505, 57-506, 57-507, 57-508, 57-509, 57-510, 57-511, 57-512, 57-513, 57-514, 57-516, 57-517, 57-519, 57-520, 57-521, 57-522

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.

Prerequisites: 57-273

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.

Prerequisites: 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

The 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

432 Course Descriptions

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: 9 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

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.

Prerequisites: 57-408

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.

Prerequisites: 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

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

Spring: 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.

Prerequisites: 57-164

57-466 Eurhythmics Applications for Performing and Teaching

Spring: 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.

Prerequisites: 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.

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.

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.

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.

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.

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.

Prerequisites: 57-186

57-488 Advanced Solfege IV

Spring: 3 units
Continues 57-487 Advanced Solfege III.
Prerequisites: 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.

57-505 Major Studio (Violin)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-506 Major Studio (Viola)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-507 Major Studio (Cello)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-508 Major Studio (Double Bass)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-509 Major Studio (Guitar)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-510 Major Studio (Flute)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.

57-511 Major Studio (Oboe)

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 (Saxophone)

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.

57-597 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 pre-school 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.

School of Art

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 bi-weekly lecture series. Open to freshmen in the School of Art, or by instructor permission.

60-110 Electronic Media Studio I

Spring: 10 units

An introduction to the computer as a multi-purpose, art-making tool that utilizes software application programs. Students use the computer to develop a variety of two-dimensional imagery, animated and interactive artworks. Multiple output media and distribution options are explored. Open to freshmen admitted to the School of Art, or by instructor permission.

60-130 3-D Media Studio I

Fall: 5 units

An introduction to three-dimensional form and space. 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 3D1 requirement. Students are required to select two of the following four mediums:

Section A: Wood; Section B: Welding; Section C: Clay; Section D: Mixed Media. Materials fee required. Open to freshmen in the School of Art, or by instructor permission.

60-131 3D Media Studio II

5 units

A continuation of exploration of three-dimensional form and space. 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 3DII requirement. Students are required to select two of the following four sections: Section A: MoveIt: an introduction to kinetic sculpture; Section B: Moldmaking; Section C: Mixed Media; Section D: Contextual Practice: works that target specific public sites, situations, and audiences. Materials fee required. Open to School of Art sophomores, or by instructor permission.

60-141 Black and White Photography I

All Semesters: 9 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

All Semesters: 10 units

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 III

Fall: 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.

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.

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.

Prerequisites: 60-205

60-210 Electronic Media Studio II

Fall and Spring: 10 units

Introduction to video production. Explore video art production, post and pre-production. Focus on skills needed to realize intended video projects through discussions and examples of processes, techniques and aesthetic issues. We will look at multi-media, computer effects and digital audio. We will move from traditional narrative to experimental and performative/installation work.

Prerequisites: 60-110

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: 60-151

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' and 1920 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 transferences, cultural isolation and extremes, multiple cultural exchanges over long periods of time, cultural antagonism, cultural extermination and genocide, cultural transplantation, 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 picturing 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 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.

60-358 Art and Biology

Intermittent: 9 units

This studio/laboratory course will examine similarities, differences and 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. It will explore the relationship between the working processes of visual artists and experimental scientists. Both artists and scientists seek to discover fragments of reality in the process of working either in the studio or the laboratory. Both disciplines seek to increase levels of observation, awareness, and perception. In addition to art/science projects, the course will include lectures, discussion, slide/video and media presentations, and reading assignments. Students will be introduced both to the work of artists whose art is based in science as well as to the work of scientists who use visual data to inform their scientific work. Students will have an opportunity to experiments creatively with scientific media such as electron and video probe microscopy. Students will be evaluated on their projects and class participation. Classes will meet in the School of Art (College of Fine Arts) and

the Department of Biological Sciences (Mellon Institute). Open to juniors and seniors only. Registration requires the permission of the instructor. Email pm3k@andrew.cmu.edu

60-371 Breathless: International New Wave Cinemas

Intermittent: 9 units

60-371 Breathless: International New Wave Cinemas (Melissa Ragona)--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 "Pathar 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 studios, lesser-known actors over box-office idols, and small production teams over professional crews, these directors were able to turn lo-fi aesthetics and financial shortcomings into a radical new filmic style. Especially central here will be how forms of cinematic experimentation 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

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 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 and 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.

60-377 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.

60-381 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 spaces, museums, as treasuries of culture and of cultures, museum 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 as museums, donor memorials, museum operations, museum shops, 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, multidisciplinary, 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, multidisciplinary, 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.

60-409 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.

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 CS3 Pro and Adobe Photoshop CS3 extended.

Prerequisites: 60-210

60-412 Advanced ETB: Special Topics in Interactive Art and Computational Design

All Semesters: 10 units

This is an advanced studio course in arts computing and new media practice. Topics surveyed 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 15-100. Although the course will provide technical introductions to major arts-programming toolkits (including Processing, Max/MSP/Jitter, openFrameworks, and Arduino), assignments can be executed in the student's preferred programming environment. Graduate students should register for section 62-726 (12 units) which meets with the undergraduate section 60-412 (10 units).

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 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. Prerequisites: 60-110 and 60-210

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.

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 orientated 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 Advanced ETB: Gizmology

Intermittent: 10 units

Gizmology introduces artists to the fascinating, real world of three-dimensional time-based/kinetic media. Students will be given intensive instruction in digital electronics as well as an introduction to mechanics and machine/sculpture fabrication. Students will complete assignments as well as pursue their own self-directed kinetic project. A \$60.00 material fee is required. 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 liveness, 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 otherwise 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: 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 inter-disciplinary 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.
Prerequisites: 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.

60-437 Advanced SIS: Environmental Sculpture

Intermittent: 10 units

Studio focus on sculpting with the environment. Design and build natural growing systems to enhance the built environment and/or landscape, public open space, empty urban lots, etc. Includes object making, installations and site work issues with an emphasis on ecological materials, environmental impact and sustainable systems. Students required to explore and to develop proposal-making skills and collaboration in order to implement a specific project in conjunction with: The fourth year Architecture Design Studio: Systems Integration- 48-405. The particular site to explore is the Hamnett Homestead in Wilkensburg, a historic house to be converted into a sustainable building and landscape to become part of an urban farm with a vision for the neighborhood to evolve into an ecovillage.

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 dada 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: The Storefront Project

All Semesters: 10 units

Students in this class will be creating art, design, and humanities projects in and around the East Liberty neighborhood of Pittsburgh, using the Waffle Shop (description below) as their base of operations. This class is about direct engagement with the public using any means necessary. Students can create projects within the Waffle Shop or develop other forms of public engagement with area businesses, sites, and community organizations. The Waffle Shop is a neighborhood restaurant that produces and broadcasts a live-streaming talk show with its customers, operates a changeable storytelling billboard on its roof, and runs a revolving take-out window from its backdoor that sells food from countries engaged in conflict with the U.S. (Conflict Kitchen) In the fall, the Conflict Kitchen will be featuring the country of Afghanistan and there will be multiple opportunities for students to help create a publication, blog, and event programming in relationship to Afghani food, culture, and politics. This is a truly interdisciplinary class and students from throughout the university, in addition to the School of Art, are encouraged to enroll.

60-450 Advanced PDP: Drawing

Intermittent: 10 units

Studio course with an expanded definition of drawing to include a large variety of media, methodologies and practices. Subjects will include observable sources as well as conceptual approaches. Students will be encouraged to identify resources, research and develop a sustained body of work.

60-453 Advanced PDP: 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.
Prerequisites: 60-150 and 60-250

60-455 Advanced PDP: Intaglio

Intermittent: 10 units

60-455 Advanced PDP: Intaglio. 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.
Prerequisites: 60-251

60-456 Advanced PDP: 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 PDP: Serigraphy

Intermittent: 10 units

Advanced PDP: Serigraphy. Studio focus on processes and artmaking issues related to water-based/acrylic serigraphy. Emphasis on individual conceptual/artistic development. Material fee required.

60-462 Advanced PDP: 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/combining of 2-D work, including installation, site consideration and other potential mediums.
Prerequisites: 60-150 and 60-151 and 60-250

60-463 Advanced PDP: 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 PDP: Printstallation

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.

Prerequisites: 60-251

60-471 Advanced PDP 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.

60-486 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 art materials in the nineteenth century, the distance between chemist & artist increased until the two worlds have little to do with one another. This class aims to reconnect the two disciplines for a study of their common ground. Students will learn about the origin of the color of minerals with primary focus on colors that originate from electronic transitions & will work collaboratively on hands-on laboratory research projects that involve the synthesis, characterization, & use of inorganic pigments. In the studio, they will make their own egg-tempera paints, & use them in painting projects designed to increase color skills as they learn about the history of pigment use. Students will collaboratively design & carry out final projects which combine research, experimentation & creative work.

A series of researchers who work at the boundary between art & chemistry will give guest lectures, & 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.

CFA Interdisciplinary**62-100 Critical Histories of the Art**

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: 9 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.

62-165 Mutable Landscape: Drawing and the Digital Photographic Image

Spring: 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.

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: 9 units

This course introduces freshman students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) Programs to research methodologies. Part 1 examines the two main paradigms that form the basis of research in various fields of inquiry: a) the systematic, scientific, or positivist approach, and b) the qualitative, ethnographic, and ecological or naturalistic approach. Part 2 consists of a guest lecture series entitled Carnegie Mellon, a University as envisioned by Andrew Carnegie, Andrew W. Mellon and Henry Hornbostel. It uses the university as a laboratory of study for integrating the multiple disciplines taught at Carnegie Mellon through various methods of teaching and learning the language of each discipline to a diverse group of students. Part 3 is dedicated to the students' research project presentations. This course is taught by the program's director with the participation of guest lecturers.

62-241 Black and White Photography II

Intermittent: 9 units

A continuation of topics explored in Black and White Photography I with an emphasis on aesthetic development and image evaluation. Students will gain experience with a variety of formats; experimental methods and media will be encouraged. Folio or equivalent required by end of the semester. Course has lab fee. Black & White I (62141, 60141, or 51265) or consent of instructor. Prerequisites: 62-141 or 60-141 or 51-265

62-245 Portrait Photography

Intermittent: 9 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

Introduction to Hot Glass I - 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. 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.

62-250 Beginner Beadmaking

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 skill at making a round bead and learn how to 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 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.

62-255 Imagery in Glass

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.

62-265 Alternative Photo Processes

Spring: 9 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

62-325 View Camera

Intermittent: 9 units

The nature of a 4x5" view camera alters both the process of making a photograph and the qualities of the resulting image. The slow, even cumbersome, process of photographing with a large format camera encourages a methodical, studied approach. The larger negative size and the ability to control the exposure and development of each sheet of film make possible an image of extraordinary clarity and detail. Through a series of exercises followed by a self-selected project, students in this class will learn the technical aspects, and master the use of, the view camera. Topics include: perspective and focal plane control, bellows extension factor, and basic B&W sheet film handling and processing. Students should enter this course already possessing a working knowledge of photographic processing and printing. Prerequisites: 62-141 and any 200 level photo course or consent of instructor. Prerequisites: 62-205 or 62-241 or 62-245 or 62-265 or 62-326 or 62-337 or 62-381 or 62-141

62-329 Modern Ruin

Intermittent: 9 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. Prerequisites: 62-141 or 60-141 or 51-265

62-330 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: 9 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.

Corequisites: 62-141, 62-241

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 how to troubleshoot 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 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.

62-350 Art Money and Power in History: China vs. the West

Spring: 9 units

How have artists made money across history? How did money and power influence their creative careers? The purpose of this course is to compare art in its socio-economic and political contexts in China and in the West. It will examine how art, money and power interacted in important periods in art history: Classical Athens, Carolingian Era, early Renaissance in Florence, Dutch Republic in the 17th century, France in the 18th and 19th centuries, and in the United States of America since 1945. They will be compared with China in the Qin, Tang, Song, Ming, Qing dynasties and China since the 1911 Revolution. We believe that, when studied comparatively, art is an integral part of the society.

62-358 Art and Biology

Intermittent: 9 units

This studio- laboratory hybrid course explores the fusion of art and biology. It is an opportunity for students interested in interdisciplinary concepts to work both in a fine arts environment and a biological laboratory. In addition to art-science projects, the course includes lectures, discussions and media presentations. Students are introduced both to the work of artists whose art is based in science as well as to the work of scientists who use visual data to inform their scientific work. 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 and Spring: 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: 9 units

This course takes part in and appreciates the anti-digital movement by exploring the roots of photography. Students will shoot with an array of large format cameras and print imagery using 19th and 20th century processes. Students will value having 'hands-on' control over the image from the beginning to the end product- which is a 'one-of-a-kind' photographic image. Course topics include shooting with different cameras (4x5, 8x10, pinhole, and zone plate), making contemporary tin-types, and working in alternative printing techniques. Prerequisites: 62-141 and 62-241 or 62-265 or consent of instructor. Alternative process or view camera knowledge a plus. Prerequisites: (62-141 or 60-141 or 51-265) and (62-241 or 62-265)

62-381 Color Photography and Digital Output

Fall and Spring: 9 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 Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) 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, and may be worth 3, 6, 9, or 12 units of academic credit. 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 director of the BXA Programs.

62-400 BXA Capstone Project

All Semesters: 9 units

The BXA Capstone Project allows Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The Senior Project should reflect the student's interdisciplinary vision in the arts and humanities, arts and sciences, or arts and computer sciences. The creation and completion of such a project can be an important integrative and fulfilling capstone for BXA students. Capstone Projects are semester-long or year-long (9 units for one semester -62-400; or 18 units for two semesters - 62-401 & 62-402), and are structured as independent studies under the supervision of a single faculty member or a small committee of faculty from the areas relevant to the project. To register, the student must submit a "Capstone Project Proposal Form" signed by the student and faculty advisor, along with a proposal, to the director of the BXA Programs for final approval.

62-401 BXA Capstone Project

All Semesters: 9 units

The BXA Capstone Project allows Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The Senior Project should reflect the student's interdisciplinary vision in the arts and humanities, arts and sciences, or arts and computer sciences. The creation and completion of such a project can be an important integrative and fulfilling capstone for BXA students. Capstone Projects are semester-long or year-long (9 units for one semester -62-400; or 18 units for two semesters - 62-401 & 62-402), and are structured as independent studies under the supervision of a single faculty member or a small committee of faculty from the areas relevant to the project. To register, the student must submit a "Capstone Project Proposal Form" signed by the student and faculty advisor, along with a proposal, to the director of the BXA Programs for final approval.

62-402 BXA Capstone Project

All Semesters: 9 units

The BXA Capstone Project allows Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The Senior Project should reflect the student's interdisciplinary vision in the arts and humanities, arts and sciences, or arts and computer sciences. The creation and completion of such a

project can be an important integrative and fulfilling capstone for BXA students. Capstone Projects are semester-long or year-long (9 units for one semester -62-400; or 18 units for two semesters - 62-401 & 62-402), and are structured as independent studies under the supervision of a single faculty member or a small committee of faculty from the areas relevant to the project. To register, the student must submit a "Capstone Project Proposal Form" signed by the student and faculty advisor, along with a proposal, to the director of the BXA Programs for final approval.

62-410 Art Science Technology in Context and Society

Spring: 10 units

This advanced seminar/workshop designed for BXA seniors wishing to pursue graduate studies at the Entertainment Technology Center (ETC), comprises various modules - each devoted to a specific theoretical and applicable topic in the arts, science, and technology. Topics include game design, computer animation, computer music, recording techniques, interactive stagecraft, robotic art, and other emerging media. Each module is taught by a specialist and coordinated by the program's director. This course is offered in co-operation with the Entertainment Technology Center (ETC).

62-420 Aesthetics and Critical Judgement

6 units

In this course, we will examine the question of how one judges a work of art. The course will provide an overview of the history of aesthetics in the Western tradition, and in the process we will examine the central questions of: defining beauty, evaluating the artistic object, determining what external factors are relevant to aesthetic judgments (time, culture, biography), and analyzing the inter-relationships between artist, audience, and artistic object. Beyond the knowledge gained, course objectives will include the cultivation of analytical skills in evaluating artistic expression and aesthetic theory, and the development of expository writing and speech skills in aesthetic analysis.

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 shapes. 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.

62-450 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.

62-451 Flame II - Molding Moretti

Fall and Spring: 3 units

Students will hone their torchworking skills while learning new techniques for sculpting soft glass in the flame. This class will include a deeper exploration of marble making and beadmaking, and expand into more advanced techniques including cane pulling and the sculpting of small figures such as insects. Flameworking 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. 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

Fall and Spring: 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. Flameworking 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 \$225. 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 \$250. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-458 Beadmaking II

Spring: 3 units

Now that you're hooked on beadmaking, you have to learn more! Increase the sophistication, complexity and design of your beads by adding more complex skills to your repertoire in this class. Shapes such as square, hollow and ornate beads will be reintroduced. You will also learn about color mixing, murrine making and adding metals to your beads. 24 hours beadmaking class/workshop experience, or permission of the instructor required. Basic materials provided.

62-459 Stained Glass

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.

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/fail only. Prior to enrolling in an internship, the student must have a "BXA Internship Proposal Form" signed by their site supervisor and approved by the director of the BXA Programs.

H&SS Interdepartmental

65-201 Humanities Scholars III

Fall: 9 units

Picasso and Matisse: Artistic Friends or Foes? Henri Matisse and Pablo Picasso were arguably the greatest of the 20th century European 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. This course fulfills the General Education Category "Reflecting: Societies and Culture."

Prerequisites: 65-102

H&SS Interdepartmental

66-221 Legal Topics: Intermittent

Intermittent: 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 conform 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. Prerequisites: 66-501

The Major in Information Systems

67-100 Information Systems Freshman Workshop

Fall: 1 unit

This discussion-oriented class provides an overview of the Information Systems Program for freshman students. The Program's academic advisor facilitates discussion of the field of IS, the curriculum, and careers, as well as student life and co-curricular experiences such as internships, research, and study abroad. Guest lecturers include the IS faculty, alumni, the IS career consultant, and IS upperclass students. Discussions will include students' progress in their first semester, as well as guidance in course planning, for creating both their Spring semester schedule of classes, and for their overall four-year plan.

67-101 Concepts of Information Systems

Spring: 6 units

The course provides an overview of the core concepts of information systems, and the impact of IS on the broader world. To this end, students will be exposed to the key concepts of people, process, and technology in information systems through lecture, case study, and project experience. Time in lecture will discuss topics such as the history of IS, the economics of information, as well as the key organizational and social issues. The class will study in detail the development of an IS project, and review some of the skills necessary for successful implementation of information systems. Finally, students will put these concepts into practice by working in small teams and using HTML, CSS, and javascript to create a website.

67-102 CONCEPTS OF INFORMATION SYSTEMS

9 units

67-211 Introduction to Business Systems Programming

Fall and Spring: 6 units

This course is an introduction to the COBOL programming language. In addition to the basic syntax of the language, the course presents several information systems applications and discusses their solution in COBOL. COBOL is the most widely used language in the business community. New versions of COBOL for Unix and PC's have enhanced its status in the programming world. This class is a combination of lecture, readings, and programming. Students leave the course with an understanding of the COBOL syntax and the data file usage. The instruction emphasizes the importance of design and maintenance as well as coding in developing business applications.

67-250 The Information Systems Milieux

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.

67-272 Application Design and Development

Spring: 9 units

This course provides students with the concepts and techniques to design and develop software applications, and to understand the design process. Students will learn the importance of user-centered design and will develop a prototype of a web application as a course project. In the process of developing the application, students will learn how to design and create relational databases, how to acquire competency in new programming languages quickly, how to use the Model-View-Controller pattern to develop software applications, how to ensure technical quality in software development, and how to apply principles of user-centered design. This course is a professional core requirement, and is open only to IS sophomores and juniors. Prerequisites: 15-121 and 67-250

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 including 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. Pre-requisite: one computer programming course. Prerequisites: 15-110 or 15-121 or 15-211

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 "significant" 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

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. Pre-requisites: Junior or Senior class standing.

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, command and 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.

67-328 Distributed Application Development

9 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.

67-330 Technology Consulting in the Community

9 units

67-331 Technology Consulting in the Global Community**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 organizational world, 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 affected 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.

67-370 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 of 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 both the Policy/Organizations/Technology and the Decision Making concentration areas of the IS curriculum. Prerequisites: 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. Prerequisites: 67-250 and 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. Prerequisites: 67-373

Department of Athletics and Physical Education**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 Advanced Athletic Conditioning

Spring: 3 units

This course is designed to train the serious athlete in the development of speed, agility, power, strength, and energy systems. The teaching of both technical and physiological aspects of athletic development will be incorporated into this holistic approach applied to advanced athletics and sports.

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.

69-129 Rape Aggression 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.

69-130 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.

69-131 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.

69-132 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

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.

69-136 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

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 Rules Class for IM Officials

Spring: 3 units

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 class 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 of \$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.

Undergraduate Business Administration Program

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. This course is restricted to first-year business majors and 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

70-332 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

70-340 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 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

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

70-343 Interpersonal Communication

Spring: 9 units

This course examines various types of interpersonal communication usually found in business situations. Topics covered will vary each semester, but can include business and social etiquette, ethics in business, dressing for success, interviewing skills, leadership skills, listening skills, how to run a successful meeting, intercultural communications, motivating employees, negotiating, networking in business, non-verbal communications, performance appraisals, power communication, telephone skills and team/small group communication. Co-curricular events will be required and may include conducting mock interviews, role playing business luncheons and navigating business social events.

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 multi-media 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

9 units

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.

70-364 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 concessions, 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.

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)

70-381 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: 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

70-391 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)

70-397 Venture Capital Investing

Fall: 9 units

Angel investors and venture capitalists have become the most visible sources of investment in new businesses in the United States. This course examines the investment process from the viewpoint of the angel and venture investor, and provides the students with a framework of their investment process. The course comprises four sections: investment criteria and selection, due diligence, deal structure and valuation, and post investment management. Students will be expected, in a team setting, to move a potential investment through its diligence, deal structure and valuation stages, and present investment recommendations. Guest speakers will supplement the course.

70-398 International Finance

Fall: 9 units

This course covers three main topics: the institutional structure of the various foreign exchange markets, the measurement of risk and return in an international setting and foreign currency risk management. Applications change from year to year to reflect current events. Recent examples are the various international financial crises (Mexico 94-95, South East Asia 97-98, Argentina 2002, etc.), the application of Value at Risk principles to the measuring and managing of the risks associated with foreign investments, and issues related to economic development in China and the U.S. current account deficit.

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 and explore its potential for becoming 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 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.

70-424 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'

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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. Prerequisites: 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. Prerequisites: 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.

70-440 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: 9 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 www, 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.

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 Information Systems, 88-200.

Prerequisites: 15-110 or 15-105 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.

Prerequisites: 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. Prerequisites: 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. Prerequisites: 70-451

70-459 Web Business Engineering

Spring: 9 units

In this course students will learn how to set up a business on the Internet and how to use the Internet and other telecommunications technologies to tie businesses together to form "virtual business." Prerequisites: 70-451

70-460 Mathematical Models for Consulting

Fall: 9 units

This course introduces students to a wide variety of models and techniques used by consultants and decision-support software. It covers applications of linear and integer programming, fuzzy logic and fuzzy control, neural networks, constraint programming, Bayesian networks, influence diagrams, analytical hierarchy process and data envelopment analysis. Such heuristic methods as tabu search, simulated annealing, genetic algorithms, learning based methods, asynchronous teams and ant colonies are briefly discussed. Prerequisites: 21-257 or 21-292

70-461 Real Time Decisions with Resource Planning Systems

Spring: 9 units

This course will teach students to solve complex problems involving real-time data using a tool that is commonly used within business, Enterprise Resource Planning (ERP) systems. Emphasis will be placed on operation problems that span the boundaries of multiple functional areas within a firm. Students who take this course will not only possess significant domain knowledge, but will also be able to assess how ERP systems fit strategically with a company's strategy. Prerequisites: 21-256 or 21-257 or 21-292

70-465 Information Technology Strategy

Spring: 9 units

Information Technology (IT) has fundamentally changed the ways firms are managed and deal with their customers and business partners. This course focuses on how Information Technology can be used to create value or obtain a competitive advantage, providing an overview of fundamental strategy frameworks, underlying technologies, and recent industry trends. The goal is to understand how Information Technology enables new strategies and how existing strategies adapt to innovations in IT. At the end of the course, students are expected to have an understanding of how to strategically use Information Technology and to identify and critically evaluate important changes and opportunities IT creates along the value chain.

Prerequisites: 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 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.
Prerequisites: 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.

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

Spring: 9 units

A brand's first contact with its customers is through marketing communications. Marketing strategy and execution is dependent on integrated marketing communications. Whether by advertising and sales promotion or new media and approaches, marketing communications is a major influence on business performance and culture and must be managed effectively by marketers.

This course covers the role and execution of advertising and marketing communications as it relates to overall marketing strategy.

Advertising, promotions, sponsorships, public relations, direct marketing, licensing, point of sale are explored in an advertising agency context. Student teams apply their understanding of these marketing communications tools to a real client situation, acting as an advertising agency team that develops and presents an integrated marketing communications campaign plan to brand managers and advertising agency executives at the end of the course.

Prerequisites: 70-381

70-485 Product 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 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.
Prerequisites: 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 C's: 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)

70-488 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 effect 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.
Prerequisites: 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.

Prerequisites: 70-492

70-498 Futures and Swaps

Spring: 9 units

This course provides an introduction to important practical uses of futures and swaps in speculation, hedging and arbitrage. That is, it will provide you with an introduction to modern financial engineering using futures and swaps. A secondary goal is to introduce you to the various techniques, involving these instruments, used to manage the changing market and credit risk faced by a modern global financial institution. Emphasis is placed upon real world practical examples and learning from actual trading experience. The course will use this framework to draw out the important theoretical ideas that underlie these examples.

Prerequisites: 70-391

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.

Undergraduate Economics Program

73-050 Study Abroad

All Semesters

73-051 Study Abroad

All Semesters

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

Intermittent: 9 units

A course for non-majors which explores the interplay between economics 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)
Prerequisites: 73-100

73-150 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)
Prerequisites: 73-100 and 21-120

73-200 Intermediate Macroeconomics

Fall and Summer: 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)
Prerequisites: 21-120 and (21-256 or 21-259) and 73-150
Corequisite: 21-122

73-252 Advanced Microeconomic Theory

Fall and Spring: 6 units

Mini I and Mini III 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) Course will be offered in Spring 08.
Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150

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 over-lapping generations model. (Lecture, 3 hours) Course will be first offered in Spring 08.
Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150 and 73-200 and 73-252

73-261 Econometrics

Fall: 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)
Prerequisites: 15-110 and 21-120 and (21-256 or 21-259) and (36-310 or 36-226 or 73-226 or 73-407) and 73-150 and 73-200

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)
Prerequisites: 73-200 and 76-101

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. Wherever possible, examination of the contemporary policy issues motivating major analytical developments will be included.

Prerequisites: 21-120 and (21-256 or 21-259) and 73-150 and 73-200

73-325 Strategic Behavior in Non-cooperative Games

Intermittent: 9 units

Combining non-cooperative game theory and its experimental methods in a computer laboratory environment, this course teaches students how to develop and test models of social and business interactions. Both extensive and normal form game are treated in depth, including the concept of Nash equilibrium and its refinements. In the latter part of the course, students design, run and analyze their own experiments, and do individual experimental/research projects. (Lab/Lecture, 3 hours)
Prerequisites: 73-150

73-328 Health Economics

Intermittent: 12 units

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? 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. Prerequisites: 21-120 and (21-256 or 21-259) and minimum grades of "C" in 73-150
Prerequisites: 73-150 or 73-251

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.
Prerequisites: 73-150 or 73-251

73-340 Labor Economics

Intermittent: 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 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)
Prerequisites: 73-150

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)

Prerequisites: 21-122 and (73-150 or 73-251)

73-351 Public Finance

Intermittent: 9 units

Fall or Spring 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 the society. We will evaluate possible solutions involving private, informal mechanisms as well as those requiring public sector interventions. (Lecture, 3 hours)

Prerequisites: 73-150

73-352 Public Economics

Intermittent: 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)

Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150 and 73-200 and 73-252

73-354 Law And Economics

Intermittent: 9 units

In recent years, the use of economics to analyze legal issues and decide legal controversies has been extended far beyond its original domain of antitrust and public utility regulation. Now not only scholars but also courts and regulatory bodies routinely apply economic principles to issues as diverse as the control of crime, accident law, contract damages, judicial administration, financial regulation, and pollution. This course reviews the major findings of the scholarly literature on law and economics, and emphasizes the application of economics to specific problems. No knowledge of law is presume or required.

Prerequisites: 73-250

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: 73-251 or 73-252

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 new markets and property rights for environmental resources. (Lecture, 3 hours)

Prerequisites: 73-150 or 73-251

73-359 Benefit-Cost Analysis

Intermittent: 9 units

Fall or Spring 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)

Prerequisites: 21-120 and (21-256 or 21-259) and 73-150

73-365 Industrial Organization

Intermittent: 9 units

Fall or Spring 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)

Prerequisites: 21-120 and (21-256 or 21-259) and 73-150

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)

Prerequisites: 73-200 and (73-150 or 73-251)

73-372 International Money and Finance

Intermittent: 9 units

Fall or Spring 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.

Prerequisites: (73-150 or 73-251) and 73-200

73-373 Cost Benefit Analysis

Intermittent: 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 individual's life) and the social rate of discount. Applications are considered in detail. Prerequisites: 21-120 and (21-256 or 21-259) and (minimum grade of "C" in 73-150).

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..

Prerequisites: 73-251 or 73-252

73-392 Financial Economics

Intermittent: 9 units

Fall or Spring 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.

Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150 and 73-252 and (36-310 or 36-226 or 73-266 or 73-407)

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. Prerequisites: 21-120 and (21-256 or 21-259) and minimum grade of "C" in 73-150.

Prerequisites: 73-150 and 73-200

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.

Prerequisites: 73-252 and 73-253 and 73-261

73-405 Introduction to Dynamic Economics

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.

Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150 and 73-200 and 73-252 and 73-253

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.

Prerequisites: 73-150

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)

Prerequisites: 73-226 and 73-253

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)

Prerequisites: 73-200 and (73-251 or 73-252)

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)

Prerequisites: 73-150 or 73-251

73-426 Advanced Quantitative Economic Analysis

Intermittent: 9 units

This course builds on the concepts developed in 73-226 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 yields useful predictions and insights. (Lecture, 3 hours)

Prerequisites: 73-226 and 73-261 and (73-251 or 73-252)

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.

Prerequisites: (73-150 or 73-251) and 73-226

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 analytical 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. (Lecture, 3 hours)

Prerequisites: 73-150 and 73-226

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 the 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. (Lecture, 3 hours)
Prerequisites: 73-150

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.

Prerequisites: 73-150 and 73-200

73-465 Technology Strategy

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.

73-469 Global Electronic Markets: Economics and the Internet

Fall: 9 units

Fall or Spring The information revolution brought about by the Internet is having a dramatic impact on the organization of 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)

Prerequisites: 73-251 or 73-252

73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property

9 units

Fall or Spring Healthy economies in many way 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)

Prerequisites: 73-150

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)

Prerequisites: 73-150 and 73-200 and (70-208 or 73-226)

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. Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and a minimum grade of "C" in 73-252.

Prerequisites: 73-251 or 73-252

73-497 Senior Project

Fall: 9 units

A fourth-year project course, open only to Economics primary and additional majors with Senior standing.

Prerequisites: 21-120 and 21-122 and (21-256 or 21-259) and 73-150 and 73-200 and 73-252 and 73-253 and (36-310 or 36-226 or 73-226 or 73-407)

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.

Department of English

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 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 2010: In the first chapter of one of the most notorious college novels, Stover at Yale (1912), Dink Stover imagines the glories that await him when he arrives: "They had begun at last — the happy, care-free years that every one proclaimed. Four glorious years, good times, good fellows, and a free and open fight to be among the leaders and leave a name on the roll of fame. Only four years, and then the world with its perplexities and grinding trials." The freshman of 2009, however, confront mounting student debt, accounts of gruesome college shootings, pressure to succeed from parents and peers, as well as the distractions of video games, college parties, and the internet. In this course we think about how we got here through the genre of the college novel, from the best selling classic, F. Scott Fitzgerald's *This Side of Paradise*, May Sarton's *Faithful are the Wounds*, Michael Chabon's *Wonder Boys*, and Buchi Emecheta's *Double Yoke*. We'll also see the film version of some of these novels, including the silent film, *The Plastic Age* (1925), and the film version of *Wonder Boys*, which was filmed here at CMU!

76-144 English Freshman Seminar

Intermittent: 9 units

Topics vary by semester. Fall 2010: Through weekly readings, presentations, and writing exercises students will explore the ways in which humor, politics, gender, spirituality, cross-genre collaborations, 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 locutions and neologisms like Harryette Mullen's "burly mugs" and Wanda Coleman's "buddahflies."

76-145 Freshman Seminar

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Fall 2010: This seminar will focus on the novels Jane Austen wrote, the times in and for which she wrote them, and the film adaptations that have been made of them. It will include the study of Austen's six finished novels: *Sense and Sensibility*, *Northanger Abbey*, *Pride and Prejudice*, *Mansfield Park*, *Emma*, and *Persuasion*; some accounts of the events and issues in turn of the century (her dates are 1775-1817) England, and some critical responses to her work. Simultaneously, we will be thinking about why Austen's rather formal fictions have inspired so many film and video productions in the last few years—and, of course, watch those productions, including *Clueless*.

76-206 Introduction to Creative Writing

Intermittent: 9 units

This is not a workshop, but an introduction to the craft of creative writing. The class will read individual collections of poetry and fiction by contemporary authors in addition to a variety of essays written by poets and writers on the craft. A small percentage of class time will be

spent on the critique of student poems, and original student writing and critical papers will represent much of the grade. Attendance and participation in class and at public readings are expected.

76-213 19th Century British Literature

Intermittent: 9 units

Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Summer 2009: This class will explore Gothic literature of the Victorian period in England (1837-1901). Though the Gothic as a genre was arguably played out by the 1820s, its conventions continue to permeate literature, appearing in penny dreadfuls, ghost stories, sensation fiction, detective stories, adventure novels and science fiction. We will read stories in which England, explosive with expansion, progress and industry, is represented as a site of degeneration and decay. We will consider how xenophobia, urban development and industrialism, science and medicine, empire, sexology and the New Woman shape representations of the Gothic. These stories of the supernatural fly in the face of science and rationality. Our texts will include: James Malcolm Ryner's penny dreadful *Varney the Vampire*, or the *Feast of Blood* (1847-48), Emily Bronte's *Wuthering Heights* (1847), Edward Bulwer-Lytton's *The Hunchback of Notre Dame* (1859), some short ghost stories by Elizabeth Gaskell and Charles Dickens, H. Rider Haggard's *She* (1887), H.G. Wells' *The Island of Dr. Moreau* (1896) and Bram Stoker's *Dracula* (1897).

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 novellas 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.

Prerequisites: 76-101

76-217 Contemporary 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 1920's? In the 1950's? 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 teen 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.

Prerequisites: 76-101

76-221 Studies in Classical Literature: Books You Should Have Read By Now

Intermittent: 9 units

It may seem more and more difficult to get a good classical, liberal education these days. The demands of professional training force many of us to skip 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 any more. 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.

76-227 Comedy

Intermittent: 9 units

We can't, of course, expect to come up with an absolutely complete definition of the comic, but for our purposes we can consider it as an embodiment of the opposite of "gravity." Comedy is characterized by its levity. This does not mean, of course, that it is any less "serious" than tragedy, even if—or especially—because it tends to favor the superficial over the profound. Indeed, if tragedy is adolescent, then the mature, adult mode is the comic, being more social and rational. A key characteristic of comedy is wit—or simply intelligence. Comedy involves a lot of pure play of the mind. It turns out that there have been a few notable attempts to help us understand just why comedy is the "social" genre beyond all others, why the comic attitude is the civilized, urbane, mature view of life. And we'll consider some of those theories while trying to understand why some things are comic and some are not. We'll consider several classical works of comic literature, beginning with Aristophanes, Shakespeare, and moving on to more recent examples, including some films.

76-232 African American Literature

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Spring 2010: This class re-examines the literary history of twentieth century African American literature through the lens of speculative fiction. While all literature could be said to "speculate" on their topics, this class will define speculative as the science fiction, horror, and magical realism genres. The category of "speculative fiction" is broad enough to include such canonical writers as W.E.B. DuBois, Ralph Ellison, and Toni Morrison; as well as some under-exposed authors like George Schuyler, Octavia Butler and Samuel R. Delany. Over the course of the semester, we will use these authors and others to interrogate central questions about Black identity, politics and culture.
Prerequisites: 76-101

76-235 20th Century American Literary and Cultural Studies

Intermittent: 9 units

Topics 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 picture when he said, *A best-seller was a book which somehow sold well because it was selling well*. Course requirements will include a midterm exam, a presentation, and a final paper based on the presentation, as well as intensive reading.
Prerequisites: 76-101

76-237 Postcolonial Literature

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.

76-238 Media and Film Studies

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Summer 2010: "I liked the movie, but the book was better." How many movie patrons have said these words upon leaving a theater? And why, exactly, is the book always better than the movie? This course will focus on the processes of translation that occur when popular novels become popular movies. For while it is a common assumption that fewer Americans today read novels, the vast majority of popular films

today are still born from literary roots. And, as statistics show, most novels gain wider readership and generate more profits after they have been released as popular films. In this course, we will study the relationship between books and movies with respect to a number of current works. This course will therefore be jointly invested in film and literature, and will cover a wide range of contemporary films and their literary predecessors, including, for example, the 2008 Oscar-winning *No Country for Old Men* (based on the novel by Cormac McCarthy). We will also examine a number of non-traditional novels, like *Coraline* (based on the graphic novel by Neil Gaiman), and *The Fantastic Mr. Fox* (based on the children's novel by Roald Dahl), and their transformation into non-traditional movies using alternative forms of animation and visual aesthetic. Finally, we will look at key arguments and controversies built into these processes of transformation, including reviews and editorials (such as those generated with regard to the making of the Harry Potter film series), in order to build an understanding of the stakes included in the practice of turning books into movies.

76-239 Introduction to Film Studies

Intermittent: 9 units

This course will serve as an introduction to the history and theory of film. It will cover the history of film from 1895 to the present, focusing on the technological, industrial, and aesthetic development of the medium. It will also introduce students to significant currents of film theory from auteur theory, to psychoanalytic criticism, to recent developments in the philosophy and historiography of film. We will closely trace the development of the American film industry in its relation to other national cinemas, beginning with the earliest films of Thomas Edison, the brothers Lumière, and other pioneers of the medium. We will also look at (among other things) examples of classical Hollywood production, Italian neorealism, The French new wave, new German cinema, The new Hollywood, Bollywood, the American blockbuster, new Asian cinemas, and the recent, amorphous category of American "indie." In doing so, we will attempt to define and interrogate the notion of a national cinema. In addition to acquiring overall knowledge of film and film theory, students will develop the skills necessary for critical analysis of cinema and media arts.

Prerequisites: 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 brief responses in class from time to time, write three prepared essays, and take a final exam.

76-247 Shakespeare: Comedies and Romances

Fall: 9 units

This is an introductory course on "the Bard" for those who think that coming to college and not reading Shakespeare would be like going to the Sistine Chapel and not looking up. Our reading list will be *The Comedy of Errors*, *Love's Labor's Lost*, *The Merchant of Venice*, *Twelfth Night*, *Measure for Measure*, *Pericles*, *Cymbeline*, *The Winter's Tale*, and *The Tempest*. *Othello*, a tragedy, will help us give focused attention to questions of genre by way of counterpoint. Plots, jokes, conventions, and contexts—we'll discuss them all. Students at the end of the course should expect to have a good grounding in the language, themes, and characters of Shakespearean comedy—it'll come in handy sometime, surely!—and perhaps more importantly be

equipped to think carefully about Shakespeare's plays in relation to history, politics, and genre. Assignments will include one short paper, one longer paper, and performance of a scene.

76-260 Survey of Forms: Fiction

Fall and Spring: 9 units

Fall 2010 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. Writing exercises will be devoted to such aspects of fiction as description, characterization, and narration, and to the writing of scenes and stories. In the second half of the course, students write a full short story of around 10-12 pages due two weeks before the end of the term. These are distributed to the class, discussed, and revised. Spring 2010 Section B: This course will use flash fiction (stories of 1,200 words or less, usually much less) to explore fictional form: character, plot, dialogue, point of view. Through the modeling and reading of contemporary sudden fiction, students will pinpoint and refine concise writing skills that will then be applicable to any kind of creative prose. You will be asked to lead a class discussion, write a short-short story a week, revise, revise, revise, and compose stories on post-it notes to create a creative installation for public view. A final portfolio composed of both critical and creative work is required.

Prerequisites: 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.

Prerequisites: 76-101

76-262 Survey of Forms: Nonfiction

Intermittent: 12 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 an 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.

Prerequisites: 76-101

76-265 Survey of Forms: Poetry

Fall and Spring: 9 units

This course is designed to familiarize students with the elements of poetic craft through actively studying and practicing a range of poetic forms. Class will involve presentations and essays as well as some workshoping of the poems students write in these forms. Near the end of the semester, students are required to submit a portfolio of "formal" poems they've written during the course.

Prerequisites: 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. Writing assignments include exercises that prepare students to write a polished short script—the blueprint for a well-told screen story. Students will also write short papers on assigned viewings.

Prerequisites: 76-101

76-270 Writing for the Professions

All Semesters: 9 units

Writing in the Professions is a writing course specifically designed for juniors and seniors majoring in all departments 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 and related communications skills you will be expected to have as you make the transition from student to professional. In the course, you learn to analyze the audience, purpose, and contexts of specific communications problems; to transform that analysis into a plan for creating a usable document that communicates your message

effectively; and a method for generalizing that approach to allow you to tackle and be successful at new communications and media as they arise. Specific genres covered in the course include resumes, internal and external communication (including email for business purposes), proposals, instructions, and writing about technical or expert information for non-expert audiences. The course also includes oral communication and the effective use of visual elements. The course requires that students work both independently and in groups.

Prerequisites: 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 the Department of English, particularly Professional or Technical Writers. 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.

Prerequisites: 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.

76-294 Interpretive Practices

Fall and Spring: 9 units

This course introduces and explores some important theories and interpretive strategies for understanding literary or visual texts, including poetry, 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.

Prerequisites: 76-101

76-300 Professional Seminar

Fall: 3 units

This once-a week, 3-unit seminar is designed to give writing majors an overview of career options in professional and technical writing. Practicing professionals in a range of communications fields corporate communications, information architecture, public relations, journalism, science writing, healthcare communications, writing for non-profits, and writing for the software industry, for example come to campus to talk with students and answer questions. Speakers generally talk informally about what they do, how they got into their fields, how students can prepare to enter those fields, and related career options. At the end of each session there is generally time for students to ask questions and talk individually with speakers. The course is required for first semester MAPW students and open to all English undergraduate majors, who are encouraged to take it in their sophomore or junior years. Grading is based solely on attendance, and there are no tests or assignments.

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, do some related research and short writing assignments, and meet periodically with the internship coordinator to discuss your internship and related professional issues. The first step is to contact the instructor to set up a time to talk about your interests and what opportunities are open to you. You should do this before registration week so we have time to make necessary arrangements.

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 1972 Aime 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.

Prerequisites: 76-101

76-313 19th Century Literature: British Literature of the Romantic Period

Intermittent: 9 units

Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2009: Emily and Charlotte Bronte revolutionized the ways in which the novel unflinchingly expressed the complex terrain of female subjectivity. They call up images of feral heroines, tortured heroes, windswept moors and lives of rainy darkness. Both women's novels were wildly popular, rocketing especially Charlotte to the status of national celebrity, yet at the same time, both women were castigated for creating heroines who were morbid, angry and masculine. This course will examine the works of Charlotte and Emily Bronte, beginning with their fascinating juvenilia and continuing through Elizabeth Gaskell's fascinating biography of Charlotte. We will read Jane Eyre, Wuthering Heights, Vilette, The Professor and excerpts from the sisters' journals as well as period and current critical responses to their works.

Prerequisites: 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, Spring 2010: From about 1880-1900 England witnesses a re-emergence of Gothic fiction, a mode noted for its excess and lurid depictions of sexuality, death, disease and madness. Themes of disorder and descending darkness characterize such texts as Dr. Jekyll and Mr. Hyde (1886), She (1887), The Great God Pan (1890), The Island of Dr. Moreau (1896), Dracula (1897), and Heart of Darkness (1899). Each novel picks up long-standing Gothic conventions, infuses them with a marked anxiety that England is entering a dangerous, possibly permanent, decline, and characterizes England as plagued by all kinds of "degenerate" threats both at home and abroad. Period writings related to technology, medicine, the New Woman, criminal anthropology, sexology and imperialism will assist our reading of these texts within their cultural moment.

Prerequisites: 76-101

76-317 American Literature: Romanticism, Realism and Naturalism

Intermittent: 9 units

Topics vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2009: This course will provide a survey of the major canonical writers of nineteenth century American literature. The course will be broken into three sections covering American Romanticism, Realism and Naturalism. We will read such classic American writers as Poe, Hawthorne, Whitman, Dickinson, Twain, Crane and Sinclair, to name a few. We will be reading these works in the context of major historical, social and political events as they unfold throughout the 19th century.

Prerequisites: 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. 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 there is a whole different worldview behind a foreign accent. The same word or phrase in English might actually carry very distinct connotations for someone whose native language is French, German, Russian, or Japanese. 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 examples of communication in the international arena and we will have a chance to meet some experienced professionals in this field. The requirements for this course include a fieldtrip and a report, one short paper, and a take home exam.

Prerequisites: 76-270 or 76-271

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.

Prerequisites: 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 2010: Literary critics and historians have labeled the 19th century novel as predominantly realist. This course will investigate what it means to think of the real in fiction. We will read some of the most important novels produced in Europe and the U.S. Likely authors will include Austen, Scott, Stendhal, Balzac, George Eliot, James, Zola, Howells, and Tolstoy.

Prerequisites: 76-101

76-324 Topics in Rhetoric

Intermittent

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.

76-325 Topics in Rhetoric

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.

Prerequisites: 76-101

76-327 Special Topics in Literary and Cultural Studies

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Summer 2009: The Lord of the Rings has been hailed as one of the most widely read books of the twentieth century, second only to the Bible. In this course, we will examine The Lord of the Rings to gain a deeper understanding of the trilogy itself and to consider different approaches to literary analysis. We will begin by considering The Lord of the Rings as Tolkien's attempt to write a mythology for England that was

influenced by Beowulf. We will read both Beowulf and Tolkien's essay "Beowulf: The Monsters and the Critics," which emphasizes Beowulf's literary, rather than historical, importance. With this as a foundation, we will embark on *The Fellowship of the Ring*, *The Two Towers*, and *The Return of the King*. We will also read a variety of literary analyses of *The Lord of the Rings*. These literary analyses approach the trilogy in terms of its genre, its publication and reception, its author's religious beliefs and experiences in World War I, and its representations of gender, race, and the environment. Although we may occasionally refer to the films, our primary focus will be on the books themselves.

76-329 Global Women's Writing

All Semesters: 9 units

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 the globalization of 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.

Prerequisites: 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 2010 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*, Tennyson'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.

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, prodigies, 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 explained 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. Example, Fall 2009: This course will introduce students to the controversies, trends, new genres and extra-literary influences that have shaped African-American fiction and non-fiction since the beginning of the twenty-first century. We will start the class in the late 20th century with the work of older, more canonical authors like Percival Everett, Toni Morrison, Gloria Naylor and Ishmael Reed. However most of the course will focus on the work of newer authors like E Lynn Harris, Colson Whitehead and Paul Beatty. We will also explore newer genres like Hip-Hop Lit, "Ghetto Lit," Christian Inspirational and non-traditional forms like the graphic novel.

Prerequisites: 76-101

76-335 20th Century Literary and Cultural Studies: Postmodern Am/Brit Fiction and Film

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Fall 2007: This course will provide a clear and lucid introduction to major postmodern American and British postmodernist. The key texts are Doctorow's *Ragtime*, Robert Coover's *The Universal Baseball Association*, and Graham Swift's *Waterland*. The themes to be explored are the relationship between postmodern and modern novels in terms of themes, narrative techniques, and material culture. This will be accomplished via a select reading of short essays and interviews by these novelists and by contrasting them with at least one novel by the modernist Philip Roth. The novels will be grounded in their times by discussions of postmodern architecture in the United States and what that means in terms of an artistic involvement with the fast changing world of globalization. This will be supplemented by film screenings (and discussions) of movies like Monty Python and the Meaning of Life and *The Matrix* that will serve to highlight the radical questioning of grand theories that have been traditionally served to explain social and literary phenomena. This will enable us to see the socio-cultural context of plurality and diversity that underscores our contemporary life and thought.

Prerequisites: 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 *White Tiger*, Pankaj Mishra's *Temptations of the West: How to Be Modern in India, Pakistan and Beyond*, Kiran Desai's *The Inheritance of Loss*, Indra Sinha's *Animal's People*, Monica Ali's *Brick Lane* and Jhumpa Lahiri's *Unaccustomed Earth*.

Prerequisites: 76-101

76-338 Media and Film Studies

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Summer 2010: The films in this course were made from the 1940s to the early 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*, *Vertigo*, or *Chinatown*. Others have been regarded as "minor" but exceptional films with growing reputations—*Gun Crazy*, *Kiss me Deadly*, *The Big Heat*. Several films belong clearly to the genre of "film noir" (those of 1944-56); others transform 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 (*L.A. Confidential*, *Psycho*) or dream-like obsessive states (*Mulholland Drive*). Thus there is a cluster of intriguingly related energies and preoccupations in these films we will explore in various ways. 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.

Prerequisites: 76-101

76-339 Advanced Film and Media Studies

Intermittent: 9 units

Topics will vary by semester. Fall 2010: Taught by Schusterman Visiting Filmmaker Ayelet Bargur and covering both documentary and feature films, the course will introduce students to current Israeli

film productions, with an emphasis on their sociological and political aspects. "Current" Israeli cinema refers to Israeli film productions in the last 10-15 years. Focusing on cinematic representations of war and trauma, military service, the Holocaust, the Israeli/Palestinian conflict, and the multifaceted Israeli Jewish identity, this course will attempt to provide insight into Israel's culture and its indigenous filmmaking. Questions about this course can be directed to Dr. David Shumway (shumway@cmu.edu).

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.

Prerequisites: 76-101

76-344 Studies in Print Culture

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2010: Censorship? Banned books? Book burnings? Could it happen here? In mid-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 many of them found ways to tell their stories, regardless of the consequences. In this course we will examine 3 kinds of censorship: political censorship, especially of the anti-Communist variety, racial censorship, and sexuality censorship. We will read texts such as Arthur Miller's *The Crucible*, Walter Bernstein's *Inside Out: A Memoir of the Blacklist*, Richard Wright's *Black Boy*, Harper Lee's *To Kill a Mockingbird*, J.D. Salinger's *Catcher in the Rye*, and James Baldwin's *Giovanni's Room*. Shockingly, the musical *Grease* and a high school production of *The Crucible* were both banned in Fulton, Missouri, in 2006. We will watch the documentary about this, just released, *Small Town Culture War*. We will also celebrate the American Library Association's banned book week, which is September 25 to October 2.

Prerequisites: 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.

Prerequisites: 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 2009: 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, so one purpose of the course will be to define it. We will read stories and novels by writers beginning with the "minimalism" of Raymond Carver, reading up to current work by Junot Diaz and Cormac McCarthy.

Prerequisites: 76-101

76-349 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 WW II.) 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 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.

Prerequisites: 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 www.cmu.edu.thinktank <<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.

Prerequisites: 76-101

76-359 Planning and Testing Documents

Intermittent: 9 units

Conducting research is crucial to the creation and evaluation of communicative artifacts; good research ensures that communication professionals make appropriate decisions when writing or designing, and that they can justify those decisions with data. This class will explore a wide range of research activities that are appropriate for writers and designers. Through lectures, class discussions, and assignments, students will learn methods and reporting techniques associated with creating and testing documents.

Prerequisites: 76-270 or 76-271 or 76-272

76-360 Literary Journalism Workshop

Spring: 9 units

While culture becomes increasingly obsessed with celebrities, contemporary literary journalism is writing that usually focuses on so-called ordinary people in various social contexts. The emphasis is to use the journalistic essay to reveal character rooted in and influenced by a particular time and place. Students will be required to do a series of short essays, and one long essay, on subjects of their own choosing. These essays will almost always involve field research; one goal of the course will be to acquaint students with research techniques and methods. This is both a reading and writing intensive course, and will be run usually as a workshop. The class is designed for both the professional writing student and creative writing student.

Prerequisites: 76-260 or 76-261 or 76-262 or 76-265 or 76-270 or 76-271 or 76-272 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-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

Naturalism has been described both as "brutal photography" and "scientific objectivity" in which fictional characters are portrayed as pawns on a larger and indifferent chessboard. The American version followed the French origins as practiced by such writers as Balzac and Zola, stressing the controlling effect of fate or destiny that directs the characters to cruel, sometimes arbitrary endings. The materialistic motives of men and women are often at the center of their actions. Perhaps, the simplest analysis of naturalism was provided by the critic Vernon Parrington in his list of what he considered to be the genre's criteria: 1. Attempted objectivity. 2. Frankness of description and expression. 3. Amoral attitude toward material. 4. A philosophy of determinism. 5. Pessimism. 6. Strong characters possessing animalistic or neurotic natures. This is a reading course, so the major portion of responsibility will be spent in the discussion of the assigned readings. Papers will be required for each of the seven novels to be read. These are to be personal responses to the novels—not critical analyses and of no more than two pages in length. A final paper will be required; subject and length to be announced. Reading assignments have been distributed into segments approximately 100 pages each. Here are the novels to be read: Maggie, a Girl of the Streets by Stephen Crane, McTeague by Frank Norris, Sister Carrie by Theodore Dreiser, House of Mirth by Edith Wharton, Native Son by Richard Wright, To Be Announced, The Darling by Russell Baker. (See Department for full description.)

76-363 Reading in Forms: Poetry

Intermittent: 9 units

This course will examine the work of various contemporary American poets. Through reading and writing poems, students will investigate how current poetry relates to past poetic movements, as well as how it relates to their own developing aesthetics. 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. Prerequisites: 76-101

76-364 Readings in Forms: Fictions

Intermittent: 9 units

Topics vary by semester. Fall 2010: Naturalism has been described both as "brutal photography" and "scientific objectivity" in which fictional characters are portrayed as pawns on a larger and indifferent chessboard. The American version followed the French origins as practiced by such writers as Balzac and Zola, stressing the controlling effect of fate or destiny that directs the characters to cruel, sometimes arbitrary endings. The materialistic motives of men and women are often at the center of their actions. Perhaps, the simplest analysis of naturalism was provided by the critic Vernon Parrington in his list of what he considered to be the genre's criteria: 1. Attempted objectivity. 2. Frankness of description and expression. 3. Amoral attitude toward material. 4. A philosophy of determinism. 5. Pessimism. 6. Strong characters possessing animalistic or neurotic natures. This is a reading course, so the major portion of responsibility will be spent in the discussion of the assigned readings. Papers will be required for each of the seven novels to be read. These are to be personal responses to the novels—not critical analyses and of no more than two pages in length. A final paper will be required;

subject and length to be announced. Reading assignments have been distributed into segments approximately 100 pages each. Here are the novels to be read: Maggie, a Girl of the Street by Stephen Crane, McTeague by Frank Norris, Sister Carrie by Theodore Dreiser, House of Mirth by Edith Wharton, Native Son by Richard Wright, To Be Announced, The Darling by Russell Baker. Prerequisites: 76-101

76-365 Beginning Poetry Workshop

Intermittent: 9 units

This course is an introduction to revising and rewriting poetry. Through weekly exercises, the composition of new poems, and thoughtful peer critique, students will experiment with the various ways in which their poems can be improved, or, perhaps, left alone over the course of a semester. We will continue to generate new work, but think more seriously about the transition from Survey of Forms to a targeted workshop environment. We will examine poems in a series and the ways in which poets sustain recurring characters and ideas in a linked series. By analyzing poetry journals, interacting with journal editors, and communicating with peers, students will differentiate between editing, revision, critique, and personal taste, and ultimately take responsibility for the workshop environment they help shape. Prerequisites: 76-265

76-372 Introduction to 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. Prerequisites: 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. Prerequisites: 76-101

76-375 Magazine Writing

Fall: 9 units

In this course we'll be reading lots of great non-fiction, some of which has appeared in magazines during the past few years. We'll look at how excellent non-fiction for magazines has to employ a strong narrative voice, and the techniques of story telling. 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 76-261 or 76-266 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 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.
Prerequisites: 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 SOS 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. (Please see English Dept. for full description.)

Prerequisites: 76-101

76-385 Introduction to Discourse Analysis

Fall: 9 units

"Discourse" is language: people talking or signing or writing. Discourse analysts ask and answer many kinds of questions about how and why people do the things they do with language. We study the structure of written texts — the semi-conscious rules people use to organize paragraphs, for example — as well as the unconscious rules that organize oral discourse such as spontaneous stories and arguments. We study how people show each other how to interpret what they say as foreground or background information, casual remark or solemn promise, more of the same or change of topic. We look at how grammar is influenced by what people need to do with language, and how discourse affects grammar over time. We ask how children and other language learners learn how to make things happen with talk and writing. We ask how people learn what language is for, from exchanging information to writing poetry to perpetuating systems of belief. We analyze the choices speakers and writers make that show how they see themselves and how they relate to others. (Choices about how to address other people, for example, both create and reflect relationships of power and solidarity.) We study how people define social processes like disease, aging, and disability as they talk about them, and how language is used to mirror and establish social relations in institutional settings like law courts and schools as well as in families and among friends. This course touches on a selection of these topics and gives students practice in paying close attention to the details of language. The course is meant for anyone whose life work is likely to involve critical and/or productive work with language: writers and other communication designers, critics who work with written or spoken texts, historians, actors, sociologists, and so on.

Prerequisites: 76-270 or 76-271 or 76-372 or 76-375 or 76-472

76-386 Language & Culture

Intermittent: 9 units

As the title implies, this course begins in the assumption that language and culture are inseparable and focuses on the many complex and reciprocal relationships between them. We examine various theories of language, analyze their implications, and evaluate how each helps or hinders our understanding of specific language practices and the social and cultural contexts within which they are embedded. Thus, we look at language practices from individual, social, and cultural perspectives and ask these kinds of questions: How language practices shape/are shaped by individuals? by groups

— national & international, cultural, social, professional? by history, policy, and established norms? How language practices change over time? What factors influence practice and change? To examine these and related questions, we read both theoretical and analytical works, examine case studies of specific language practices (and disputes), and conduct independent research on current language practices. For the final project, students choose, research, and analyze a language issue or practice of specific interest to them.

Prerequisites: 76-101

76-387 Sociolinguistics

Intermittent: 9 units

This course provides an overview of the field of sociolinguistics, or the study of language in its social and cultural contexts. Among the questions posed in the course are these: How and why do speakers select among the range of linguistic varieties in their repertoire, standard and vernacular, regional-sounding or not, more writerly or more oral, gendered in one way or another, and so on? How can such variation be accounted for in a theory of language? What kind of grammar is involved in knowing how to participate in conversations, and how do conversational styles differ from group to group? What causes misunderstanding and what enables understanding in interaction among people who are different? What are the effects of multilingualism and language contact, for speakers and for languages? How and why do standard varieties of languages come to be, and how are they perpetuated? What are the relationships between language, society, and the individual speaker? There will be several written assignments in addition to regular reading assignments, as well as a mid-term exam and a final project.

76-389 Rhetorical Grammar

Intermittent: 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.
Prerequisites: 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, concision, 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?
Prerequisites: 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 (In Design, Photoshop, and Illustrator) will be taught in class, and used to create the assigned projects.

Prerequisites: 76-270 or 76-271 or 76-272

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, *FAHRENHEIT 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, or conducting interviews and surveys. Students will also learn how to situate their work in the context of scholarly conversation, by testing their hypotheses against alternative and presenting their research to audiences in the field of English studies. To ground the discussions, the course uses a thematic content: it looks at the experience of political exiles and refugees in the post-World War II era.

Prerequisites: 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 76-372 or 76-375 or 76-472

76-396 Non-Profit Communication: Genres, Methods, and Issues

Intermittent: 9 units

Given the changes brought on by the information age, non-profits, like all organizations, face an increasing diversity of audience and media choices. What hasn't changed is the need for effective arguments and strategies that respond to both the situations at hand and their organizational contexts. In this course, we examine the critically important practices of argument and advocacy in the context of non-profit communication (i.e. arts, education, advocacy, and public service). We will look at how arguments respond to communication philosophies, to organizational goals and, of course, to rhetorical situations. Among other questions, we will ask these: How does speaking in the "voice" of an organization change the way we communicate? How can we adapt the genres of organizational communication including print, electronic & social media to meet our organization's goals in a given situation? And how can we have impact while working with limited budgets? The end result will be a professional portfolio that demonstrates both relevant workplace skills and a high-level of theoretical understanding about what makes a public argument successful. Students will also gain experience in translating their technical expertise into language designed for potential employers. We'll focus on non-profits, but the techniques we'll learn are also broadly applicable to communications careers in other sectors.

Prerequisites: 76-270 or 76-271 or 76-272 or 76-372 or 76-373

76-397 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 (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

76-412 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: This seminar will explore both plays and the social contexts for drama and the theatre in late 17th and 18th-century Britain. We will read work by writers such as Aphra Behn, William Wycherley, Susanna Centlivre, Richard Brinsley Sheridan, and Matthew Gregory "The Monk" Lewis. We will also read modern research into the social contexts of theatrical performance in the "long 18th century," as well as paying attention to the performance history of plays. But we will not to stop there. We will frame our explorations through the interdisciplinary field of performance studies. Emerging from anthropology, semiotics, theater studies, and cultural studies, performance studies brings to theatre history an interest in how embodied performances, as well as texts, transmit meanings over different time periods and in different geographical places and cultural locations. Students can expect to learn about an important early chapter in Anglophone theatre, as well as to acquire exciting new theoretical frameworks for thinking about theatrical performance.

76-413 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 2010: In the early decades of the twentieth century, Irish and British writers transformed literary representation, abandoning the certainty of Realism to delve into representations of the human subconscious resulting in fractured narratives in keeping with the uncertainty of that historically pivotal time. As conceptions of national identity were called into question with traumas associated with the First World War, Modernist writers attended to the tensions between wholeness and disintegration in the individual and in collective bodies. In Irish and British Modernism we will explore the tensions between illusions of a whole associated with political movements like nationalism and fascism and the disorienting though sometimes liberating forces of disintegration that surfaced in the essays, poetry, plays, novels and short stories of four Modernist writers: James Joyce, Virginia Woolf, William Butler Yeats and T.S. Eliot. American Modernism will be offered in the spring, which will build off elements of this initial introduction to Irish and British Modernism. Requirements for this course will include active participation in class conversations, bi-weekly response papers and a fifteen to twenty page research paper.

76-414 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.)

Prerequisites: 76-101

76-419 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 e-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.)

Prerequisites: 76-101

76-420 Process of Reading and Writing

Spring: 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.

Prerequisites: 76-101

76-422 Theories of Sexuality and Gender

All Semesters: 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 Rubin'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 Fielding's Female Husband, Foucault's *Herculine Barbin*, Sandy Stone's and Susan Stryker's theoretical work in this area or the biographical writing of "gender warriors" such as Leslie Feinberg.

Prerequisites: 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 in the nineteenth century, there has been a growing presence for science and technology in the lives of everyday citizens. In some cases, these phenomena have sparked the public's imagination and their promise has stirred their confidence in a better future. In other cases, they have kindled fears and generated protests over the risks of new technologies and the threats of novel scientific ideas to prevailing social, cultural, economic, and political orders. This course examines the complex dynamics in the relationships between science, technology, and society. Towards this end it engages with questions such as: How do we decide who an expert is? To what extent do scientists have an obligation to consider the social and ethical consequences of their work? Is public education about science and technology sufficient for addressing social concerns about risk and controversial scientific ideas? We will grapple with these and other questions by exploring modern public debates in which science, technology, and society play a primary role such as the AIDS crisis, global warming, and the autism vaccine debate. With the help of analytical theories from sociology, rhetoric, and public policy, we will develop a general framework for thinking about argument and the dynamics of the relationship between science, technology and the public. In addition, we will look to these fields for tools to assess specific instances of public debate and to complicate and/or affirm the prevailing theories about their relationship. See English Department for full description.

76-428 Visual/Verbal Communication

Intermittent: 9 units

People create a wide range of communicative artifacts that integrates visual and verbal elements—newsletters, product brochures, web pages, graphical novels, journal articles, resumes, software references, yellow stickies, etc. Yet, such visual-verbal discourse has only recently attracted the serious attention of research communities. Some of the relevant research questions include: Why do visual variations exist across different contexts? (e.g., Popular science looks different from Discover.) Why and how do visual styles change over time? (e.g., Magazines from the 1950s don't look like present day magazines.) Do visual elements have persuasive power? If so, what roles do they play in shaping an argument? How do people learn to communicate using visual-verbal artifacts? In this seminar, we will address these and other questions through readings and discussions on various threads of studies around the analysis of communicative artifacts that integrate visual and verbal expressions. We will review key research publications concerning visual-verbal communication from relevant disciplines, including professional & technical communication, rhetoric, argumentation, and literacy. Particular attention will be paid to descriptive methods (e.g., social-semiotic analysis, visual argument, and rhetorical structure theory) and the types of questions these methods can help us answer. Throughout the semester, students will be encouraged to explore the visual-verbal communication artifacts found around them and use those to connect class discussions to the practice of design. Required assignments include a brief bi-weekly response to the readings, several short analysis papers, and a longer term paper with a topic chosen by students based on their professional or research interests. (See English Department for full description.)

Prerequisites: 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*, Tennyson'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.
Prerequisites: 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. Most class meetings 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 the pilgrim through whose eyes you will read each of the tales; in addition, of course, to seeing from your own 21st-century vantage point. Sometimes "your" pilgrim's reactions will be specified in the dramatic frame begun in the General Prologue; sometimes you will have to speculate. In addition to the tales, prologues, and epilogues of the text, we will also be reading brief accounts of 14th-century institutions and traditions (chivalry, fabliaux, marriage, etc.). 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.
Prerequisites: 76-101

76-432 Advanced Seminar in African American Studies: Ralph Ellison

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. Example, Fall 2009: This course will be an in-depth study of Ralph Ellison's works as well as the writers and thinkers that influenced him. Ellison's life spanned much of the twentieth century and reflects the great artistic, political and cultural transformations that America has undergone since the turn of the twentieth-century. The primary focus will be on Ellison's connection with Cold War writers and intellectuals like Hannah Arendt, Irving Howe, Ayn Rand, Richard Wright and Robert Penn Warren. In particular, we will explore Ellison's relationship to what Frances Stoner Saunders calls the "cultural Cold War." However we will also read the works of T.S. Eliot, Henry James, Mark Twain, William Faulkner, Franz Kafka, Andre Malraux and others who were crucial influences on Ellison's thought and craft.
Prerequisites: 76-294
Corequisite: 76-394

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 literacy 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.

76-438 Advanced Seminar in 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: *Airtime: Radio, Television and Culture* in the 20th Century. In this advanced course we will examine the cultural history and interpretation of radio and television. How do we apply the fields of literary studies and cultural studies to these vast, almost infinite forms of media? These are still relatively new fields, and thus we will look at new research, and you will also be expected to conduct new research of your own. Our readings will include Lynn Spigel, *Welcome to the Dreamhouse: Popular Media and the Postwar Suburbs*, Paul Buhle, *Hide in Plain Sight*, Michele Hilmes, *Radio Voices*, Robert McChesney, *Telecommunications, Mass Media and Democracy*, and Curtin and Spigel, eds., *Revolution Wasn't Televised*.
Prerequisites: 76-238 and 76-239 and 76-294

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. Example, Fall 2010: Where do films come from? We usually think of adaptation or multi-media cross-promotion as a recent phenomenon. But, in fact, the process of adapting a literary work from one form into another is as old as culture itself. In this course we'll be looking at novels, plays, and television screenplays that were made into feature films during the 1940s, 1950s and 1960s. We will watch the teleplay, *Marty*, which was made into an Oscar winning film starring Ernest Borgnine in 1955. We will look at the novel *7 and 1/2 Cents* that spawned the wildly successful Broadway musical (and film) *The Pajama Game*. We'll look at the short story that inspired Andy Griffith's first star turn in *A Face in the Crowd*. We will read the proletarian novel *Chris in Concrete*, and see the Italian version of the American novel that was suppressed for political reasons in 1949. We will read the play *Raisin in the Sun* and see the film based on it, starring Sidney Poitier, in 1960. As we compare the various versions of each story, we'll be tempted to conclude that "the book was better than the movie." Instead, however, we'll think about how the meaning of the story changes when the form changes as well. Interpretation, rather than hierarchy, will be our goal.
Prerequisites: 76-101

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, Philip Larkin, 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.
Prerequisites: 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.

Prerequisites: 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 2009: History of the English Language is widely taught in English departments, and besides supplying an essential historical perspective on the language of the documents that we study, offers a significant extra qualification for anyone planning an academic career in a Department of English. The topic is vast: 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 socio-cultural significance. The periods studied will include: the Germanic background; Old English; Early and Late Middle English; Early Modern English; Present Day English. We will study short texts characteristic of their time. Class lectures, readings and, if possible, visiting speakers will fill in details of cultural and literary events of relevance to the periods. Required texts will include John Algeo's workbook *Problems in the Origins and Development of the English Language*. Class meetings will consist of lectures and discussion of readings. The course is open to all Master's degree students (MA in Rhetoric, MA in LCS, MAPW, MDes), all doctoral students (Ph.D. in Rhetoric, Ph.D. in LCS), and to undergraduate English majors with Senior status. Others by permission.

Prerequisites: 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 also 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. Example, Fall 2010: Since the 1978 publication of Edward Said's groundbreaking work *Orientalism*, postcolonial theory has gained currency as a critical discourse examining global experiences of colonization and decolonization. At the center of these discussions have been questions of identity—ethnic, linguistic, and cultural—at the crossroads of competing histories, agents and cultures. Since the term "postcolonial" was first invoked to describe the cultural effects of colonization, the field of study has expanded considerably. Today postcolonial studies looks backwards at earlier works on nationalism and cultural identity; gazes toward the future of globalization; and scrutinizes regularly its own interpretive legitimacy. In this course, we will follow several threads of postcolonial theory. Readings will include Edward Said and Anne McClintock on the discursive operations of empire; Ngugi wa Thiong'o and Aijaz Ahmad on the politics of representation; Frantz Fanon, Partha Chatterjee and Chandra Mohanty on nationalism and its discontents; Homi Bhabha, K. Anthony Appiah and Stuart Hall on race, ethnicity and hybridity; Gayatri Spivak and Trinh T. Minh-ha on the gender and postcolonial subjectivity; and finally, Arjun Appadurai and Arif Dirlik on the cultural implications of an increasingly globalized economy.

Prerequisites: 76-101

76-457 Topics in Language Study: Historical Linguistics

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. Spring 2008: Methods for the study of change in language, including the comparative method, internal reconstruction, and typological reconstruction. Problems in distant linguistic relationships and the propagation of languages; language contact, language birth, language death. Prerequisite: an elementary knowledge of phonetics or phonology, such as a course in which a certain amount of phonetic transcription was practiced.

Prerequisites: 76-101

76-460 Beginning Fiction Workshop

Fall and Spring: 9 units

Fall 2010: In this workshop students will read stories and novels, write critically about these works of art, and create their own short stories. Knowledge gained in Survey of Forms will be put to use as students deepen their understanding of what it means to write good fiction. Each student will produce 25 pages of fiction, two critical essays, and be expected to participate in an ongoing class discussion focused on both professional and student work. Spring 2010: 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. In this class we will work on narrative voice. Using masterworks to help guide our writing, we will spend the first part of the semester writing stories that imitate the style or narrative voice of several authors. You will have a story due every week. 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. Required readings: *The Sun Also Rises*, *The Razor's Edge*, *The Virgin Suicides*, *Possession*, and *White Noise*.

Prerequisites: 76-260

76-462 Advanced Fiction Workshop

Fall and Spring: 9 units

The principal project is the creation of a first chapter or chapters of a proposed novel to a hard copy minimum of 35 pages. This work in progress will be reviewed in class as it develops. In addition, a synopsis or schema of the proposed novel will also be required and prepared for class review. An additional writing assignment—a reversal—will be a scene drawn from the synopsis and assigned by the instructor. E.M. Forster's "Aspects of the Novel" will be the text as well as samplings of first chapters of contemporary novels to be supplied by the instructor. As in all workshops, class participation is of vital importance for the success of the class and determines 40% of the grade. Keeping deadlines is also important. Three unexcused absences are grounds for failure.

Prerequisites: 76-460 or 76-461 or 76-462 or 76-464

76-464 Non-Fiction Workshop: Personal Essay

Intermittent: 9 units

This is an advanced writing course that has been specifically designed for the student who wishes to polish and practice the skills of prose writing while pursuing the intellectual challenge of this particular form, the personal essay. Professional writing majors were particularly considered as "clients" for this course. The form of the personal essay did not exist until Michel Montaigne "accidentally" invented it in the 16th Century. His speculative musings, observations of nature and, especially, himself came together to make a unique genre which engages any topic while the actual subject of the essay is the essayist's mind, his or her thinking the subject through. To try to explore one's mind on a particular question has become a favorite activity of writers ever since all the way down to Emma Bombeck and Russell Baker. Essays by Montaigne will be read to see how he puts his thoughts together; was it a casual endeavor or a self-conscious craft? For us, the second method. Then, we will turn to more contemporary practitioners to study and enjoy their variations on the model. Meanwhile, students will put their writing skills to the test of this seemingly informal and arbitrary form. Some students will, at first, find it difficult not to make a point, not "to stick to the subject" the object here is to engage the full range of the mind's capacity for speculation and observation, recall and realignment of opinions and information. And, the results of this self-inquiry expressed in disciplined, lively prose. Student essays will

be workshoped in class. All papers are to be distributed to class members for a review via e-mail prior to their discussion in class. Schedules and deadlines are to be worked out between instructor and student. However, at any point in a student's career, deadlines should not be necessary. (See English Department for complete description.) Prerequisites: 76-260 or 76-265 or 76-365 or 76-465

76-465 Advanced Poetry Workshop

Fall and Spring: 9 units

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; three essays on the selected poems of various contemporary poets (including Billy Collins, Denise Duhamel, Harryette Mullen, and Cornelius Eady); 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

Prerequisites: A student must receive an A or B in 76-269: Survey of Forms: Screenwriting in order to enroll in 76-469. A student who received a C in 76-269 may enroll in 76-469 only with the permission of the 76-469 professor. A student who received a D or R in 76-269 may not enroll in 76-469. In this screenwriting course we will go beyond the conventional three-act structure and explore more inventive approaches. The course will challenge writers to take creative risks with genre, tone, character, and structure. It will explore mainstream, personal, and experimental narrative forms, surveying both American and international films. In a field where novelty often equals commercial success, we will strive to create screenplays that are innovative and exceptional. We will also try to link scriptwriting to other forms of storytelling, and discusses issues including the three-act structure, working with and against genre, character identification, and the implications of screenplay form. Key issues, examples, and case studies demonstrate what works, what doesn't, and why. Exercises will encourage writers to explore new ways of viewing their work and to test the limits of their skills. Prerequisites: 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 process whose results command instant acceptance within and without the scientific community. In this course, we will take a more sophisticated view of science considering the importance of such elements as language, genre, audience, values, and visuals in the production and acceptance 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 does the institutional and social context in which science is done shape scientific knowledge? What is the difference between arguments made for scientists and arguments made for non-scientists? In what ways does language shape scientific debate and knowledge? What argumentative solutions can visuals supply in science and what argumentative problems? 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, and communicate their work among themselves and to the public. But we will also consider how the application of rhetoric to science might re-shape our view of rhetorical theory and criticism. (See English Department for complete description.)

Prerequisites: 76-101

76-479 Marketing, Public Relations, and Corporate Communications

Spring: 9 units

The world has become a battleground in the shaping public opinion around millions of competing messages, brands and ideas. In virtually every facet of modern life, public relations and corporate communications are at work to influence attitudes, perceptions and human behavior, shaping and molding the way we think, buy, invest, vote, and participate in a democratic society. This course, taught by a practicing public relations expert with over 20 years experience in the field, explores public relations, marketing and communications in various organizational settings business, non-profit, academic, special interest groups where professional communicators manage relationships with a wide variety of constituencies: customers, investors, employees, local communities, and 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 effectively to persuade and bring about desired organizational objectives. In this course, you'll learn the fundamentals of professional public relations and corporate communications and the written and oral skills needed by professional communicators in any organization. You'll learn public relations problem solving, design effective marketing and public relations strategies, and develop skill in the common genres of public relations including press releases, op-ed essays, and communication plans. You'll also get practice in collaborative planning and problem solving paralleling current business practices. The course is relevant to students considering communications careers in these areas as well as those interested in developing practical communication skills relevant in all professional settings.

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

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multimedia software, Macromedia 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 or 76-272 or 76-260 or 76-269) and (76-391 or 76-382 or 76-383 or 76-487)

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 different 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, homepages, 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.

Prerequisites: 76-101

76-487 Online Information Design

Fall: 9 units

* Students taking On-Line Information Design must register for both 76-487 and 76-488 or receive permission from the instructor to omit the lab. Online information design focuses on the issues and practices surrounding user-centered design for on-line applications. In other words, our goals focus on helping users easily perform tasks that meet their stated goals in a web-based interface. We focus our attention on three core design issues. These include user studies: by studying the literature on users as well as analyzing interviews and observations of actual users, important features and content concerns emerge that can be incorporated into the finished deliverable; information architecture: by studying the literature on site architecture as well as considering how actual users interact with the architecture of a particular site, important features and content approaches emerge (including organization, navigational design, link labeling, form and search design, and visual design) that can be incorporated into the finished deliverable; synthesis and application: by synthesizing those two elements, and applying the lessons learned to a partial redesign of a selected site, you develop the knowledge needed (including methods of iterative design, and methods for evaluating and reporting on a design's usability) to succeed in the interdisciplinary world of information design. The course's primary focus will be on the design of text/image information typical of Web sites, though issues in on-line design for other modes, such as sound and animation, as well as Web 2.0 will be touched upon. A series of homework assignments ask students to analyze and report on user needs, information architecture, and to iteratively redesign an existing Web site. The course includes exams and a final project.
Prerequisites: (76-270 or 76-271 or 76-272) and (76-391 or 76-382 or 51-261 or 51-262)

76-488 On-Line Information Design Lab

Fall: 3 units

Lab exercises for On-line Information 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 (76-391 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%.
Prerequisites: 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 policy analysis which focuses attention on the values, beliefs, and argument structures associated with public issues. Towards this end, we will be studying the theories and analytic methods of both classical and modern rhetorical scholarship as well as modern public policy theory. Over the course of the semester, we will combine knowledge and techniques from both fields to examine a current issue in American public debate and probe the strengths and weaknesses of rhetorical and non-rhetorical approaches to policy. No previous experience with public policy is necessary for this course. Those with experience are welcome.

Prerequisites: 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 and sponsor the project, develop and complete senior projects that involve either traditional academic research or investigations of problems in professional or technical communication.

Department of History

79-104 Global Histories

All Semesters: 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 cyclonic 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 assessment of available scholarship as well as an examination of primary sources in various published sources, microfilm, and archival collections at Carnegie Mellon and the University of Pittsburgh.

79-157 Freshman Seminar: Feast & Famine: Population & Family Systems in Past and Present

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; 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

Living 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. It will look historically at institutions which are integral to African societies, such as patron-client relationships, marriage, and pawnship. It will interrogate the multiple ways that these institutions functioned before the period of the trans-Atlantic 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.

79-167 Freshman Seminar: Issues in American Environmental History

Intermittent: 9 units

This seminar will focus on major issues in the evolution of the American environment. Much of America's past environmental history has been beset with controversy, as scientists and engineers, health officials, politicians and the public debated about the cause and solution for various environmental problems. This seminar will examine some of the major environmental issues that have evolved over time through a combination of reading, discussion, and short papers.

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; Balanchin 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 life, writings, and speeches as the foundation for a larger investigation into the history of race and, in particular, the struggle to achieve racial equality within the United States. We will read 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.

79-174 Freshman Seminar: North of the Border Mexican Immigration Past and Present

Intermittent: 9 units

In the past decade we have been bombarded with information about Mexican immigration, some of which is inaccurate or incomplete, some of which is highly charged emotionally and politically. This phenomenon of movement to the north has a long and complex history with many dimensions, a history important to understand because what we believe about the past influences our perceptions of the present. In this course we will explore, among other things,

the historical reasons behind the economic and social dislocations of Mexican immigrants, the impact on both the sending and receiving communities, the immigrants' integration into the U.S. economy, the changing destinations and demographics of the more recent immigrants, and barriers and facilitators to integration and mobility.

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 QPA 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, 1400-1800

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 re-imagined 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.

79-203 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.

79-205 20th Century Europe

Intermittent: 9 units

This course covers aspects of western European history from 1914 to the 1990s. Its themes are the roots of the profound crisis of democracy and civil society and the parallel rise of radical intolerance in Europe between 1918 and 1945 and the causes behind the success of democratic republics since World War II. We consider the social and economic impact of the two World Wars, the extraordinary artistic vitality of the 1920s, and the reasons why some countries produced large and successful fascist movements while others did not. We also discuss the rise of Communist parties and the crisis of democratic socialism. In the post-war era we focus on European responses to revolts against colonialism, the "economic miracle" of the 1950s, anti-Communism, and student radicalism of the 1960s. Readings include primary sources, novels, reportage, and scholarly monographs.

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 both by the revolutionary traditions born in France and processes of industrialization.

Prerequisites: 79-202 or 88-202

79-210 Islam and the Integration of Society

Intermittent: 9 units

This course offers an overview of the history of Islam as a divinely-inspired religion, and a system of thoughts, 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 Bearers

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.

79-220 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 (1920s) and ending with Hugo Chavez'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 and civil wars in Central America; industrialization and populism in Argentina; gender, socialism, and dictatorship in Chile; and indigenous people and drug wars in the Andes. Students will write short response papers and a research paper.

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 pre-Hispanic Mayan societies 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; 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.

79-226 Introduction to African History I: Earliest Times Origins of the Slave Trades

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 dynamic 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 II: 18th Century to the end of Apartheid

Intermittent: 9 units

The course is designed to give students an understanding and appreciation of African history and culture from the "inside out." Though it deals with the period of European expansion in Africa, it is centered on African language/ ethnic groups, villages, and individuals as historical actors who daily make collective and personal

decisions to pass down, innovate, and borrow practices, technology, spiritual systems, etc. in the face of social, political, and economic realities. The course is also designed to get students thinking critically about how historians select and interpret sources to construct and reconstruct history at these different levels.

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). The course will end in 1948 with the establishment of the State of Israel and the Palestinian dispersal. Students will move beyond the textbook to explore primary source documents, maps, film, literature, media, autobiographies, biographies and role playing exercises, all with the purpose of developing a nuanced understanding of the goals and priorities of the various actors in that time period. Running throughout the course is the question, was peace ever possible?

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-Israeli 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? There is minimal overlap with 79-229, Origins of the Arab-Israeli Conflict, 1884-1948, and students may take both courses. Students who previously took 79-352, The Arab-Israeli Condition, may not enroll in either 79-229 or 79-230.

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, détente, 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 region from the Cold War through today, with special attention to recurrent 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 intervention in the Middle East. Readings and discussion progress with 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 will examine the cultures and societies of the Caribbean focusing on their colonial past, their current positioning in the world, their social structure, cultural patterns and current transnationalism.

Using social history, film and music we will explore the topics of race, class, family, gender, religion, national identity and underdevelopment. Comparative research projects will provide concrete instances of the differences and similarities between the Anglo-Caribbean, Franco-Caribbean, and Hispanic Caribbean.

79-236 Introduction to African Studies

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.

79-240 The Development of American Culture

Intermittent: 9 units

This is an introductory survey of American history from colonial times to the present. The course focuses on cultural analysis instead of the more traditional emphasis on presidents, wars, and memorizing facts or timelines. The major theme of the course is the changing meaning of freedom over three centuries. Required readings include novels, memoirs, historical documents, and a study of the concept of freedom. There is no textbook; background facts and events are covered in lectures to provide students with context needed to think about and understand America's cultural history. Assignments include exams and essays.

79-241 African American History I

Intermittent: 9 units

This course examines a series of topics--economic, demographic, social, cultural and political--in African-American history from slavery to the Civil War. The evolution of race relations is an important component of the course, but the major emphasis is placed on the internal experiences of black people within the framework of larger socioeconomic and political processes in U.S. history. Although the course includes a general text, assigned readings revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the colonial, revolutionary, and antebellum eras).

79-242 African American History II

Intermittent: 9 units

This course examines the black experience from Reconstruction to the present. The evolution of race relations is an important component of the course, but the major emphasis is placed on the internal experiences of black people, within the framework of larger socioeconomic and political processes in U.S. history. Although the course includes a general text, assigned readings revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the Great Migration, Depression, World War II, and the Civil Rights Era).

79-243 African American Women's History

Intermittent: 9 units

This 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 freedwomen faced, the economic and cultural histories of black women, the politics of women's blues music (listening to a variety of blues songs), anti-lynching campaigns, labor campaigns, women's role in the Civil Rights Movement, beauty campaigns, and the Anita Hill & Clarence Thomas hearings, 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?

79-245 A History of Asian Americans in the U.S.

Intermittent: 9 units

Immigration has been a major transforming force in American history. In the past forty years the population of Asian Americans in the United States has increased dramatically and has become much more diverse. New groups have joined the earlier Chinese, Japanese, Koreans, Filipinos, and Asian Indians, and they range from peasants to Ph.D.s. In this course we will trace the history of Asian immigration to the United States and examine how historical, social, political and economic factors have both affected and been affected by this migration. We will identify and discuss the common experience of migrants across a number of time periods and Asian ethnic groups, as well as the differences that make each group's story unique. Finally, we will examine the evolution of American responses to these various immigrant groups, questioning whether the responses reflected or helped to shape the opinions of Americans in the respective time periods.

79-246 Industrial America

Intermittent: 9 units

This course examines the transformation of America into an urban industrial society during the 19th and 20th centuries. It analyzes the major economic, demographic, political, and social consequences of industrialization with emphasis on race, class, and gender. We will pay particular attention to the lived experience of workers who witnessed this transformation firsthand.

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 we'll take some time at the end of the course to consider 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 American Experience

Intermittent: 9 units

This course is designed to look at the history of the Jewish community in America up to the present time. While the history of American Jewry is more than three centuries old, we will focus primarily on the 20th century. We will explore not just historical themes and developments, but we shall also spend time focusing on contemporary issues and perspectives. In our discussion, we shall touch on aspects of American history, European history and world Jewish history. There will be a variety of classroom activities including lectures, discussion, oral reports, films and guest speakers. The aim of this course is to make each class provocative, lively and informative by raising issues and questions regarding the past, present and future of the American Jewish community.

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 a number of films about the War on Thursday evenings (along with students enrolled in The Soviet Union and the Second World War). There is no weekly Thursday evening class, although there is an occasional Thursday evening film.

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 and culture in the years 1939-1945 focusing on problems that the war presented. To understand life under the German Occupation and the collaborationist government in Vichy, 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

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, 1978-2008

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 study the controversial question of the degree to which the Communist Party is currently loosening 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.

79-275 Introduction to Global Studies

Intermittent: 9 units

"Globalization" is a familiar term that is often used to invoke the idea that places around the world are rapidly becoming more interconnected. This is so, but it is also true that this is far being from a simple or harmonious process. Rather, "globalization" involves a wide range of uneven and disputed cultural, political, economic, and social developments that often influence one another but vary markedly in their significance, impact, and intensity. Economic crisis, impoverishment, rising inequality, environmental degradation, pandemic disease, and militant ethnic, religious, and nationalist movements are just as much a part of the contemporary global landscape as are technological innovation, instantaneous communication, shifts in the global division of labor, the creation of new wealth and knowledge, the promotion and defense of human rights, and the rise of cosmopolitan values and perspectives. This course introduces you to important ways of thinking about globalization and will acquaint you with the kinds of research, evidence, and information upon which these kinds of thinking rely. It serves as a foundation for further study of the contemporary world in advanced Global Studies courses.

79-276 Theory and Practice in the Anthropology of Globalization

Intermittent: 9 units

Theories about culture and society often play an important, even critical, role in guiding historical and anthropological investigations of the contemporary world. Even so, there are great differences of opinion concerning what is meant by "culture" and "society" and how the "real world" phenomena that these concepts attempt to describe are actually interrelated. This course examines some of the most important anthropological theories of culture and society in order to better understand their characteristic strengths and weaknesses. Its aim is to help you not only to find and recognize theoretical assumptions and perspectives when you encounter them in your studies, but also to give you some practice in applying and using these perspectives to better understand the world around us. The first part of the course briefly examines anthropology's origins in nineteenth and early twentieth century social and evolutionary thought and the development of new theoretical perspectives during the mid-twentieth century. Then we will consider the impact of concerns with history, power, and domination on anthropological theory from the mid-1970s until the present with the aim of understanding their implications for global studies. As will soon become apparent, many of the key concepts that influenced the early history of anthropology are far from being dead and buried. Rather they have been continually revisited or intermittently resurrected in order to revitalize the discipline and push it forward.

79-278 Rights to Representation: Indigenous People and their Media

Intermittent: 9 units

For decades anthropologists have been picturing 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.

79-279 Comparative Study of Nationalism Case Studies: USA, Arabia, South Africa

Intermittent: 9 units

This course provides insight into one of the most important historical issues of the past century. It will enable students to develop a deeper understanding of the origins of many a contemporary state and problem in the Middle East, Africa and elsewhere. Participants will work on personal research papers pertaining to their respective nations.

79-280 Experiencing Globalization

Intermittent: 9 units

The global marketing strategies of firms such as McDonald's and Coca-Cola the use of offshore production plants and sweatshops by firms such as Nike and The Gap the struggles over fair trade coffee the rapid growth in international migration new forms of exotic tourism the dramatic increase in material inequality around the globe. These are some of the most prominent symptoms of major changes that have been taking place in the working of the world since the late 1960s. Such changes are often referred to under the general heading of globalization. How should we think about these changes? What is the relationship between their economic, political, and cultural dimensions? And, above all, how do people around the world experience them? We will explore these issues by focusing on the ways they are being addressed by socio-cultural anthropologists, historians of the present, documentary film-makers and others. We will consider the varied approaches these analysts employ. And we will explore how the challenges posed by globalization are encouraging them to re-conceptualize their objects of study and revise their modes of research. This course is meant to make it easier for you to recognize and engage the significant shifts that are taking place in the world around you, the relationships and processes that connect your daily lives to the lives of others elsewhere in the world, and the urgent contemporary debates about the current and future organization of these connections.

79-281 Introduction to Religion

Intermittent: 9 units

The objective of this course is to introduce students to the variety of intellectual disciplines by which religions can be studied and some of the topical concerns of Hinduism, Buddhism, Judaism, Christianity and Islam. Topics to be covered in the course include: What is religion? Religious studies vis-à-vis historical, anthropological, sociological, and psychological approaches to religion; the sacred/holy; myth, symbol; society and the sacred; deity; cosmogony, religious anthropology, theodicy; ethics, eschatology and secular humanism in the modern age.

79-282 Europe and the World

Intermittent: 9 units

This course provides a broad introduction to the anthropological study of transnational processes in post World War II Europe with an emphasis on the transformation of European culture and society since 1990. It also addresses some of the most critical methodological and theoretical problems involved in the study of contemporary highly developed societies. Among the topics that will be considered are the common themes of European cultures and the shifting meanings that have been assigned to the concept of Europe, the impact of globalizing processes on European social life, the resurgence of ethnic and nationalist conflicts, immigration to and within Europe, the relation between Eastern and Western Europe, and the development of the European Union.

79-283 Europe and the Islamic World

Intermittent: 9 units

From Islamic conquest of Damascus to the modern-day War on Terror, the path of European civilization has been intimately entwined with that of the Islamic world. But cooperation as well as conflict has characterized the historical interactions between Islam and Christian Europe. This class, therefore, will map out the complex winding road of Islamic-European contacts from the time of Mohammed to the modern era. Europe and the Islamic World is primarily designed to be an upper-level history course featuring frequent oral assignments, a heavy reading load, and numerous discussions of relevant primary and secondary texts.

79-284 Islam, Africa and the Arab World

Intermittent: 9 units

This course is a study of Islam's origin and doctrine, and how it spread into Africa and developed a special link between the Arabs and the Africans. It will examine the foundations and diverse facets of this link from the formative period of the religion in Mecca to the present, with an emphasis on some axial events and on the issues of mutual perception. A proper appreciation of this history may lead to a better understanding. In other words, the course will explore what is commonly known as The international Islamic solidarity, its doctrine, its scope and its limitations. This endeavor represents another way of appreciating the universalism (globalism) of Islam in today's critical era of history and politics, as the annual meetings of the Islamic Conference held since 1970, bring together the leaders of Muslim countries from the Middle East, Asia and Africa. In summary, since the seventh century, the world has witnessed a changing but constant role of Islam in the internal and external politics of many a country as well as in regional and world politics.

79-285 Islam in the United States

Intermittent: 9 units

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.

79-286 Gandhi and King: Nonviolent Leadership in a Globalized World

Intermittent: 9 units

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. We will focus, in particular, on questions of leadership, power, and nonviolence. Readings for this course will include biographies of Gandhi and King as well as the writings of both leaders themselves. Students will be encouraged to apply what they learn from Gandhi and King to contemporary local and global challenges and to developing their own leadership potential.

79-287 Colonization and De-colonization in the Pacific

Intermittent: 9 units

In this course, we will focus first on the strategies through which the US and Europe took over island nations throughout the Pacific. This will involve considering the history and meaning of imperialism in nation-states that competed for power in the 18th, 19th, and 20th centuries and, equally important, the responses of the island peoples who were subject to imperial practices. The second part of the course will concentrate on the moves toward de-colonization on the part of islanders, in the context of international and national political, economic, and cultural shifts. The third part of the course will examine the continuing impact of changing relations of power in the contemporary context. Our case studies include (among others) New Zealand, Hawaii, Guam, and Samoa. The course is part of the new Global Studies major, and draws on both anthropological and historical materials.

79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations

Intermittent: 9 units

Latin America doesn't receive much attention from the US media these days, but whether in the form of immigrant labor, a cup of coffee, or a professional baseball player, the region shapes our daily lives in many important ways. Likewise, U.S. foreign policy, military power, and popular culture affect virtually all of Latin America. This course will attempt to make sense of the tumultuous and paradoxical

relationship between Latin America and the United States from the early 1800s to the present. The course will go beyond state-to-state diplomatic relations in order to explore the cultural, economic, environmental, and social dimensions of the historical ties between the two regions. Course materials include readings, historical documents, film, music, and video. Areas covered include Mexico, the Caribbean, and Central and South America.

79-289 Energy, Environment, Globalization in the Americas

Intermittent: 9 units

The world we live in is marked by the accelerated movement of capital, goods, and people across borders. All of this movement, whether it occurs across physical or virtual space, requires energy - lots of energy. For most of recorded history, human societies derived energy from a biological regime that included soils, plants, animals, and water. This changed dramatically in the twentieth century, when the transition to a fossil fuel regime enabled unprecedented rates of consumption and wealth accumulation while contributing to equally unprecedented rates of ecological change. This course will use lecture, readings, film, and fieldtrips to explore the political, economic, and ecological dimensions of this great transformation by focusing on the Americas. Our approach will be both comparative and transnational in order to highlight both national differences and regional connections. Students will write short response papers and a research paper.

79-290 States/Stateless Societies and Nationalism in West Africa

Intermittent: 6 units

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.

79-291 Globalization in East African History

Intermittent: 6 units

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.

79-292 China Inside Out: Going Global, 19th and 21st Centuries

Intermittent: 9 units

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 sources examine efforts to "sinify" 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.

79-293 Inward Odyssey

Intermittent: 9 units

Inward Odyssey will explore world history by examining it through the outward-looking eyes of travel writers, on the assumption that travelogues, though supposedly written about the other, in fact provide crucial insights about the mindset of the culture that produced them, and often serve as a vehicle for cultural self-exploration or even self-criticism. In terms of content, this course is intended to overlap with World History, Islam and the European World, and US-Arab Encounters. However, this course is intended to be a skills course, designed not to teach students about specific historical periods, but rather to give students the tools they need to conduct their own critical explorations into the historical past.

79-295 Race Relations in the Atlantic World

Intermittent: 9 units

This course is an analysis of the dynamics of race relations in the Atlantic world 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.

79-296 Perspectives on Social Protest

Intermittent: 9 units

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 and extended 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. Using case studies from across the world, with a particular focus on Latin America but also including Northern Ireland, Algeria, India, the United States, and Japan, we will consider how cultural forms can be taken and worked into powerful and sometimes dangerous techniques of resistance. We will examine as well the challenges that groups face when they reach beyond their local cultural histories to make national and transnational connections with other groups.

79-298 Special Topics: 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. 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.

79-299 Circulation of 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. 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 globalization on these movements. We will consider 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: ethnographies, historical accounts, memoirs, and film.

79-300 History of Public Policy in the United States

Intermittent: 9 units

This course will describe and analyze 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, competition policy, the New Deal, civil rights, and drug policy.

79-303 Pittsburgh and the Transformation of Modern Urban America

Intermittent: 6 units

This mini 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, cultural, and political forces shaped the history 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, correctional, 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, 1967 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 operations of the juvenile justice system. We also analyze the portrayal of delinquency as revealed in several feature and documentary films produced between the 1960s and the present (e.g., *West Side Story*, *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 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 Italian, 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 once-a-week evening sessions will normally begin with a film viewing and conclude with discussion initially in sections. 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 of all social classes. Without neglecting 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 social contexts and state policies up to the present. 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, 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 Cultural Understanding/Misunderstanding: Culture, Histories Janpn Vietn. US Reltn

Intermittent: 9 units

Information and literary texts, sounds and images, cross borders easily in the era information networks and global markets. The question remains whether they retain their meaning. Linguists, literary critics, poets, writers, and anthropologists have all grappled with the difficulty of translating ideas across the boundaries of vocabulary, genres, cultures, and histories. Is the new mode of representation accurate to the original form? Whose perspective dominates the textual or visual materials? How do problems of translation, broadly defined, both reflect and revise relationships between individuals, groups, societies, and nations? Can a translation capture the nuances, the hidden meanings, and the cultural contexts that constituted the original? Can a translation do justice to aesthetic and moral values? Literary texts, anthropological writings, and films will be among the materials we use to examine the complex issues raised by translation. Our focus will be on relationships between Japan and the US, and Vietnam and the US. The course is part of the Global Studies major, and is cross-listed in English and History.

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 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 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.

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.

79-319 Protest and Dissent in American History

Intermittent: 9 units

What does it mean to protest in a country that was founded by revolutionaries? Are radicals heroes or traitors? Dissenters like Sarah Grimke, Frederick Douglass, Susan B. Anthony, Eugene V. Debs, Emma Goldman, Malcolm X, Cesar Chavez and others struggled for different convictions but had one thing in common: to further their causes they had to overcome the traditional aversion to radicalism in America. This course traces not only the history of particular protest movements since revolutionary times, but also the historical development of mainstream politics, law, and public opinion regarding radical dissent.

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. Do women constitute a coherent category? And can a women's rights movement represent all women? These are some of the questions at the heart of this class.

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 explore family relations in both noble and peasant families, the laws governing marriage, divorce and children, restrictions on women's movement 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.

79-323 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.

79-325 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.

79-326 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 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 women authors--including Margaret Fuller, Emma Goldman, Anna Julia Cooper, and Zora Neale Hurston, to name a few--along with a broad range of living 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.

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 ethnopsychology.

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, ethicists, 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 The Politics of American Military Recruitment: Historical Perspectives

Intermittent: 9 units

This course examines a number of major policy choices in recruiting Americans into military service, and the political and cultural controversies that have surrounded those choices, from the late 18th century to the present. The main topics to be covered - all from an historical perspective - will include: 1) the draft, the all-volunteer military, and the Reserves/National Guard as methods of military recruitment; 2) the exclusion/incorporation of African Americans, women, and gays into military service; 3) the recruitment and training of enlistees and draftees; 4) the recruitment and training of military officers; and 5) protest movements against military recruitment.

79-340 Who Shall Play? Gender and Race in American Sport

Intermittent: 9 units

This course will examine how gender and race have affected 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 and professional sports.

79-341 The Cold War in Documents and Film

Intermittent: 9 units

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 who 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 Tuesday 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.

79-347 Cross-breeds: Racial Mixing in American History and Culture

Intermittent: 9 units

For more than 400 years before the appearance of Tiger Woods, Halle Berry, Beyoncé Knowles, or Barack Obama on the scene, people of mixed heritage have been a common and yet problematic part of American communities and cultures. This course examines how definitions of race - what makes a person "this" and not "that" - have changed along with the political and cultural infrastructures that have perpetuated and enforced racism (which we euphemistically call "race") throughout the history of the United States. We will focus especially on the conflicts between prevailing conceptions of distinct racial groups ("black," "white," "red," or "yellow," for example) and the complex experiences of mixed families and individuals. We will also consider how mixed families bring out the often hidden importance of gender in defining race. Readings will include memoirs, theoretical works, historical studies, and an overview of recent genetic controversies around the "reality" of race. Assignments will include a journal, analytical essays, and a research paper. Students who enroll in this course should have already completed "Global Histories" (79-104) and "Development of American Culture" (79-240).

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 motives 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.

79-349 The Holocaust in Historical Perspective

Intermittent: 9 units

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.

79-350 Early Christianity

Intermittent: 9 units

In this course we examine the origins of Christianity. Although we deal with biblical, as well as other contemporary, materials, the approach is not theological but historical. We want to understand how and why Christianity assumed the form that it did by examining its background in the Jewish community of Palestine, its place in the classical world, its relationship to other mystery religions of the time and certain variant forms (now known as Gnosticism) which it assumed prior to the crystallization of orthodoxy.

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 processes of economic and political modernization, or becoming part of private life, religious beliefs and identities played an increasing critical role in public life. We approach the topic through case studies, beginning with the religious conflicts and settlement between church and state during the French revolution, Evangelical Christian participation in the anti-slavery movement in Britain, Protestant-Catholic rivalries in Germany, the power of the papacy in Italy, and the Dreyfus case in France. Students will have reading assignments from both primary and secondary sources.

79-354 Religion in American Society

Intermittent: 9 units

Opinion polls taken from the 1940s through the 1990s report annually that over 90 percent of Americans believe in God. Our earliest institutions, when they were not churches themselves, reflected a strong religious influence. Americans have felt religious competition so keenly in various times in our history that they have rioted in support of one denomination over another. Why was (is) this so? How have Americans experienced, thought about, and manifested their various religious beliefs throughout our history, and how have Americans interacted with fellow citizens of differing beliefs? How has religion influenced the development of our current institutions, and why do Americans believe what they do? This course examines these and other issues connected to American religious development.

79-357 Special Topics: History of Black American Music

Intermittent: 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.

79-360 Historical Evidence and Interpretation

Intermittent: 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, interviews, old newspapers, maps, and photographs. 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. Episodes in American History serve as case studies throughout the semester. 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

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 of class, gender, and race 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 6-under is Tony Soprano's 2011 business plan; 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, inclass test, and a short research paper.

79-371 African American Urban History

Intermittent: 9 units

This course will explore the African American urban experience within the larger context of U. S. urbanization. Specifically, it examines the African American encounter with cities on the Atlantic seaboard during the colonial era; the rise of Midwestern cities during the 19th century; the emergence of the Great Migration during the 20th century; and the increasing suburbanization of the black population during the late 20th and early 21st centuries. While the course will illuminate the impact of larger U. S. urban economic, political, and cultural developments on black urbanites, it will emphasize the role that African Americans played not only in the creation of their own urban communities, but in the transformation of American urban life itself. Students will read both primary and secondary accounts of African American urban history; write analytical papers on specific topics or themes; and engage in regular classroom discussions of assigned readings.

Prerequisites: 73-251 or 79-202 or 88-202 or 88-220

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

You are what you eat," or so goes the old saying. Is this true? This course considers the relationship between eating, power, culture, and identity in historical and contemporary societies. We will think about consuming food (and drink), but also the production, processing, and distribution of edibles in order to understand the meanings and social relationships associated with turning animals, plants, and other things into "cuisines" and commodities. In order to do this, participants will: read widely and in many disciplines about food; watch some film and video; dialogue with some local chefs, farmers, and retailers; write a research paper on a course-related theme; and eat!

79-379 Extreme Ethnography

Intermittent: 9 units

Observation, participation and direct experience of "the field" are hallmarks of anthropological ways of knowing, and their representation has played a foundational role in ethnographic writing both past and present. Yet reflexive and postmodernist explorations of these topics have triggered contentious debates over the nature of anthropology as a scientific or humanistic enterprise, and over its ethical, political and epistemological value. In this seminar, we will approach such questions through an exploration of the extremes of ethnographic fieldwork and writing. We will consider such topics as: the colonial history and politics of explorers and ethnographers; liminality and the place of extreme experience--such as cultural dislocation, violence, derangement, intoxication, sex, possession, and dreaming--in fieldwork and writing; field-notes as an ethnographic genre, and their relationship to "official" published ethnography; ethnographic surrealism and surrealist ethnography; the dimensions of sensory experience (visual, auditory, olfactory, etc.) in fieldwork and ethnography; collecting and the powers of "exotic" objects; inter-subjectivity and its implications; and experimentation with alternate ethnographic forms, such as autobiography, film, diary, and poetry. **Please Note**: students electing to take this class should have a background in anthropology.

79-382 History of Biomedical Research

Intermittent: 9 units

This course examines the development of biomedical research in the nineteenth and twentieth centuries, focusing primarily on the U.S., but also examining research and institutional models in Germany, France and England. Beginning with the work of Pasteur and ending with an examination of the research infrastructure supported by the National Institutes of Health in the late twentieth century, the course examines the following themes: the production of scientific knowledge as a social process; the building of a biomedical research infrastructure; the balance between social accountability and scientific independence of the research enterprise and relationships with research patrons such as government, industry and academia. In addition, the course examines the formation and reformation of biomedical disciplines and the building of the biomedical education infrastructure, with emphasis on pharmacology, physiology, immunology, neuroscience, and genetics.

79-383 Epidemic Disease and Public Health

Intermittent: 9 units

Epidemics of infectious disease are both biological and social events. Through the perspectives of the changing ecology of disease and social construction of disease, this course examines epidemics of such diseases as bubonic plague, cholera, yellow fever, and AIDS. Besides considering the social factors that help determine the epidemiology of a particular outbreak of disease, the course analyzes human responses to epidemic disease. These responses include popular attitudes toward the disease and those who contract it, as well as public health measures intended to control spread of the disease.

79-385 The Making of the African Diaspora

Intermittent: 9 units

The trans-Atlantic slave trade dispersed Africans in the New World and the Old, creating the African Diaspora. Generations of scholars have disputed whether descendants of enslaved Africans could have retained any of their African culture and/ or fully assimilated into New World societies. This course will combine a chronological, geographical, and a thematic approach to the creation of new Africa-inspired cultures in both Africa and the African Diaspora. It will explore societies in the Caribbean, the US South, Latin America, and Africa and address themes, such as Africanisms, African survivals, African retentions, Creole languages, and religion.

Prerequisites: 79-201 and 79-209

79-386 Entrepreneurs in Africa, Past, Present and Future

Intermittent: 9 units

Fifty years after Ghana, the first sub-Saharan African nation, gained its independence from colonial rule, African economies continue to rest on a fragile foundation. Entrepreneurs must play an important role in developing the African continent, because both African governments and foreign aid have overall failed. In the face of

these myriad of internal and external constraints on economic development, the history of entrepreneurship and future potential for entrepreneurship is often overlooked. This course will show that sub-Saharan Africa is—and has been for centuries—a thriving place of business, despite the obstacles of war, political and economic instability, disease, and famine. It will also focus on the challenges, such as local, regional, and national integration, access to credit and capital accumulation, and debt burden that African economies faced in the past, present, and future. Lastly, it will focus on the strategies that entrepreneurs in Africa—local and foreign—have developed to circumnavigate these challenges—and the opportunities that they have created in spite of them. By taking a historical approach to the subjects of entrepreneurship, innovation, and technology in Africa, this course will define African entrepreneurship in a way that is rooted in Africans' historical experiences and use this definition to put Africa's current and future roles in the global economy into historical perspective.

79-389 Stalin and Stalinism

Intermittent: 9 units

Joseph Stalin has been vilified and praised, damned and worshipped. He left behind a mixed and complex legacy: he created an industrialized modern economy in the Soviet Union, won a great and painful victory over the Nazis, built a police state, and destroyed the possibilities for socialist democracy. He sent millions of people to slave labor camps, and when he died, thousands wept at his funeral. This course will combine elements of biography and social history to examine Stalin, the man, and Stalinism, the phenomenon.

79-390 Nazi Germany

Intermittent: 9 units

This course will cover all aspects of life and policy in National Socialist Germany, 1933-45. We will discuss the rise of Hitler and his National Socialist party, Nazi social and economic policies, Nazi culture, everyday life under Nazism, the Third Reich during World War II, and the Holocaust. Readings will include historical monographs, memoirs, and primary documents.

79-391 Comparative Postwar Societies

Intermittent: 9 units

This course will compare and contrast the social, cultural, and political development of the United States, Great Britain, France, and (West) Germany from the Second World War to the 1990s. Themes will include electoral participation and hot political issues, gender and sexual relations, race relations and immigration, and popular culture (movies, music, visual arts). Students will read/view and discuss historical monographs, primary documents, films, advertisements, and works of art.

79-392 History of Modern Warfare

Intermittent: 9 units

This is a discussion course on the emergence of and changes in European thinking about strategy and command as well as physical and technological developments from the end of antiquity to the world wars. Topics include the gradual evolution of European military thinking away from dependence on classical thinking about warfare; relationships between firepower and the character of warfare after the appearance of gunpowder; changing conceptions of strategy, tactics, and generalship; thinking about warfare, maneuver, and battle; the experience of combat; the relationship of war to the state; and the evolution of military technology and its production.

79-395 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 \$200 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.

79-396 Music and Society in 19th and 20th Century Europe and the U.S.

Intermittent: 9 units

This course will explore 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 \$200. 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.

79-398 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 read a recent scholarly account of the war and then check it against a variety of primary source materials such as memoirs, documents, speeches, newspapers, maps, eye-witness reports and UN resolutions. We will constantly be asking if the sources support the new text or if there are other interpretations that might lead to different conclusions. We will be examining the text for tangents left unexplored and possibly worthy of further research. We will consider how politics, the availability of new archival sources, and the passage of time can also bring about a rethinking of events past. And what to make of competing or contradictory secondary interpretations, or differing accounts put forward by civilians, veterans and other Israeli and Arab scholars? Students will write a major research paper on a 1967 War-inspired topic.

79-399 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. CMU students in Pittsburgh and Qatar will utilize the newest web-camera and videoconferencing technology for the traditional in-class part of the course and enjoy a chance to work collaboratively on projects with students elsewhere in the US and the Arab world via an on-line discussion forum. Students should be prepared for a substantial time commitment to allow for the opportunity to meet and work in real time with students far from Pittsburgh. Participating schools include: Tufts, Harvard, Clark, Virginia Commonwealth, Birzeit, Qatar, American University of Cairo, American University of Beirut, and Philadelphia University (Jordan).

79-400 Advanced Seminar in Global Studies

Spring: 12 units

This intensive research seminar is the capstone course for Global Studies majors. Each year the course will have a broad theme that lends itself to the kind of multidisciplinary perspectives majors have been exposed to in previous coursework. The first part of the course will consist of discussing some key writings and approaches to the topic. The majority of the course will be devoted to defining and executing independent research projects chosen by students in close consultation with the faculty member running the seminar. Student projects may be based on in-depth readings, ethnographic fieldwork (possibly related to a previous study abroad or internship experience), archival research, literary analysis, or some combination of these methods. In addition to giving students the freedom to explore a topic of personal interest, this course will help prepare students for graduate studies in the humanities or social sciences. Intensive research, active participation in discussion, and peer-evaluation all expected. Prerequisites: 79275 and Theoretical and Topical Core must be complete or concurrently enrolled.

79-420 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.
Prerequisites: 79-200

79-449 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 which examines a compelling current policy issue which can be illuminated with historical research and philosophical and policy analysis. Based both on archival research and on contemporary policy analysis, the students develop an original research report and presentation for a client organization in the community.

79-491 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.

79-503 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.

79-504 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.

79-506 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's work. Prerequisite: Students must be Global Studies majors and obtain prior permission for the proposed internship from the Global Studies advisor.

Department of Philosophy

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 rising from 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 with 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.

80-103 Freshman Seminar

Spring: 9 units

The class will study some basic voting theory, including issues of constitutional design, voting paradoxes, and spatial models of candidates' and voters' strategic behaviors. We will use A. Downs's classic, 1957 book, *An Economic Theory of Democracy* as our principal text. Relating to our theoretical inquiry, we will examine several ways in which the Internet functions during the run-up to the 2004 US Presidential campaign. For example: • How does the Internet serve as a medium for communicating with, and among voters and monitoring their opinions as part of strategies the candidates might employ? • Do the candidates' evolving positions, as tracked on their homepages, conform to the strategies that Downs' theory entail?

80-110 Nature Mathematical Reasoning

Intermittent: 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 "Lets 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 developed countries like ours 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 The 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&SS 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 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. For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA 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

Intermittent: 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 quantificational logic. Presentation: The material is presented on-line, though 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 we use the scientific method to understand social phenomena like war and religion in the same way that we use it to understand natural phenomena like lasers and microchips. For example, humans possess free will and act with intentions while light rays do not; does this mean we must use different species of explanations in the two cases? Do simple social 'laws' exist which explain basic social norms like cooperation? Do social norms evolve in the same way as do biological species? Is our understanding of social phenomena always value laden?

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, often in very subtle ways, we make judgments of value that shape our lives and our conduct. This course provides a systematic examination of foundational concepts in ethics and the comprehensive theories that explain their importance and their relationship to one another. We will therefore examine alternative treatments of concepts such as welfare and happiness, basic moral rights, and different moral virtues. We will also analyze the role of these conceptions in different foundational moral theories such as utilitarian approaches, Kantian theories, Aristotelian ethics, contractarian moral theories, and possibly others as well. Primary readings will focus on source texts by Aristotle, Hobbes, Kant, and Mill along with secondary readings from more contemporary sources. Particular attention will be paid to locating specific areas of disagreement that distinguish competing moral theories so that we can evaluate them on a reasoned basis and make an informed decision about their respective merits and deficiencies.

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.

80-242 Conflict and Dispute Resolution

Intermittent: 9 units

Conflict just is. Understanding how and why people have different preferences for engaging in conflict will be a central theme of this course. Gender, culture, communication and conflict style preferences are a few of the influences that will be examined. Concepts or models for understanding or engaging in conflict will provide our theoretical foundation. Participating in this course will enable you to reflect on your own preferences along with how to competently engage in conflict. Your learning process will be supplemented with a variety of self-assessment tools. These and other self-assessments are essential to recognizing and developing a personal conflict style. In addition to lectures and discussions, in-class activities will include role-plays, negotiation games, and analysis of real-life conflicts. As the semester progresses, areas of interest to students will be incorporated into the learning experience. The course is restricted to juniors and seniors. Since each student brings a wealth of knowledge and experience regarding conflict, there are no prerequisites. Are you ready to challenge your pre-conceived notions about conflict?

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. The course will cover topics that should help us assess what the best relationship between humans and the rest of the natural world should be. Issues that the course may consider include animal rights, consumption, overpopulation, global warming, trade-offs between saving some parts of nature and others, and how we should think about environmental protection in developing countries.

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

Intermittent: 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.

80-250 Ancient Philosophy

Intermittent: 9 units

This course provides a broad survey of Ancient Greek philosophy from the pre-Socratics, through Socrates, Plato, and Aristotle, to the later Hellenistic writers. Through careful study of primary texts we will explore some of the historical and intellectual movements that led up to and culminated in the flourishing and downfall of Periclean Athens. A study of Socrates (as represented in Plato's early dialogues) will lead to an in-depth reading of Plato's *Phaedo*, *Meno*, and sections of the *Republic*. We will then explore Aristotle's systematization of philosophy through selections from the *Metaphysics*, *De Anima*, and the *Nicomachean Ethics*. The course will conclude with an examination of Epicurean and Stoic movements from the Hellenistic period. This course provides a strong foundation in the history of philosophy, and the history of western moral, political, metaphysical, epistemological, and psychological thought more generally.

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 they proposed. 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 (Hegel 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.

80-254 Analytic Philosophy

Intermittent: 9 units

This course examines the revolutionary impact on philosophy and contemporary thought of several scientific breakthroughs that occurred at the turn of the 20th century. By the 1920s some scientists and philosophers became hopeful that the end of the long tradition of philosophical deadlock was finally within reach. Buoyed in particular by Einstein's theory of relativity and the invention of modern logic, they created a new kind of scientific philosophy with the goal of applying logical and empirical methods to philosophical problems. The new movement became a major intellectual force until its disruption by the Second World War. From Wittgenstein's language-oriented philosophy to the scientific study of such notions as meaning, information, computation, and inference, the modern fields of linguistics, cognitive science, and information and computer sciences all owe a debt to these sources, as does of course contemporary philosophy. This course will be centered around selected readings of Frege, Russell, Wittgenstein, and the Vienna Circle, as well as the post-war reception by Quine and others.

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 emphases 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 this 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 Übermensch (overman). Throughout, we will focus on developing a

consistent interpretation of an enigmatic philosopher whose views have been mischaracterized 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 often very strange positions, and (2) to help you improve your analytical and critical skills, including, for example, extracting and evaluating philosophical arguments.

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.

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 morality ultimately depends on God's sanctions and (yes, here it is at 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

The 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 within languages. We look at earlier attempts to devise such phonological systems, and conclude with the study of modern optimality theory. In optimality theory, contrast and sameness are captured in terms of an input-output device which selects the most optimal candidate faithful enough to the requirements of contrast.

Prerequisites: 80-180

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

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.

80-300 Minds Machines, and Knowledge

Intermittent: 9 units

We examine important presuppositions in several contemporary essays that debate the scope and limits of artificial intelligence. Specifically, the class discusses contemporary views on foundational versus coherence models of human knowledge. (Does human knowledge have a secure basis or is it a mere "web of beliefs"?) These questions about the organization of knowledge are contrasted with objections raised, for example, by Searle and Dreyfus against the "strong AI" thesis of Newell and Simon. Also, we consider several current models of knowledge which incorporate probability and other measures of uncertainty, including some recent work on "parallel" systems. Pre-requisites: 80-100 or some other intro level Philosophy course.

Prerequisites: 80-100

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 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. Possible topics may include, and are not limited to: individual choice under uncertainty and related issues in the psychology of judgment and decision making, problems of public choice in which a group of individuals must collectively make a decision, game-theoretic problems of conflict and coordination, alternative approaches to the problem of fair division of goods 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 Logic and Computation

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 Computability and Incompleteness

Spring: 9 units

The 1930's witnessed two revolutionary developments in mathematical logic: first, Gödel's famous incompleteness theorems, which demonstrate the limitations of formal mathematical reasoning, and second, the analysis of the notion of computation in the work of Turing, Gödel, Herbrand, Church, Post, Kleene, and others, together with Turing's results on the limits of computation. The course will cover these dramatic advances and will put them into the context of other crucial developments in the foundations of mathematics, in particular, Hilbert's theory of proofs and Zermelo's theory of sets. Prerequisites: 15251 or 21300 or 80210 or 80211 or 80310

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.

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, conditionals, 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

An introduction to first-order modal logic. The course considers several modalities aside from the so-called alethic ones (necessity, possibility). Epistemic, temporal or deontic modalities are studied, as well as computationally motivated modals (like 'after the computation terminates'). Several conceptual problems in formal ontology that motivated the field are reviewed, as well as more recent applications in computer science and linguistics. Kripke models are used throughout the course, but we also study recent Kripkean-style systematizations of the modals without using possible worlds. Special attention is devoted to Scott-Montague models of the so-called 'classical' modalities.

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.

Prerequisites: 36-201 or 36-207 or 36-217 or 36-220 or 36-225 or 36-247

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.

80-337 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 limitations. We then proceed to discuss collective decision making by a group of rational agents. We discuss voting as a means of aggregating individual preferences, with an emphasis on

the implications of Arrow's Impossibility Theorem. Finally, we discuss measures of social welfare, both utilitarian and Rawlsian, 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 interrelated 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

Compositional semantics is the study of how the meaning of a sentence (or other complex linguistic expression) is built up from the meanings of its parts. This course provides an introduction to the practice of compositional semantics, using Discourse Representation Theory. (Although everything required for working with this theory will be taught in the class, students must be prepared to master and work with the relevant formalism.) In the first two thirds of the course, students will learn how this theory models the meanings of basic sentence types, focusing on the specific contributions of different types of nouns and noun phrase, simple verb phrases, and basic adjectives and prepositions. Linguistic meaning, however, goes beyond the simple expression of content. In the final section of the class, we will broaden our view to discuss how linguistic content is structured, discussing how information can be presented as main point, parenthetical, or background. We will also investigate the functions of expressions such as discourse markers, expressives, and utterance modifiers. By the end of the course, students will understand how linguistic meaning can be investigated and described in a systematic fashion. Prerequisites: At least one of the following: 80-280, 80-281, 80-283, 80-383, 80-201, 80-208, 80-254, 80-262, 80-270, 80-271, 80-380 OR permission of instructor
Prerequisites: 11-521 or 11-721 or 76-385 or 76-386 or 76-387 or 76-389 or 76-451 or 80-180 or 80-280 or 80-380 or 82-280 or 82-383 or 85-421

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.

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 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: 76-385 or 76-389 or 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, a branch of abstract algebra, has found many applications in mathematics, logic, and computer science. Like such fields as elementary logic and set theory, category theory provides a basic conceptual apparatus and a collection of formal methods useful for addressing certain kinds of commonly occurring formal and informal problems, particularly those involving structural and functional considerations. This course is intended to acquaint students with these methods, and also to encourage them to reflect on the interrelations between category theory and the other basic formal disciplines. Prerequisites: one course in logic or 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

This course will be co-taught by one member of History and one of Philosophy, and be taken in the fall of the senior year by every EHPP major. The purpose of the course is to give students a serious opportunity to apply the concepts and knowledge they acquired in the major to single topic, in depth. For EHPP majors only.

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 Philosophy of Mathematics

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 integers that can be represented by a given quadratic form, and 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

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 topoi. 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. Prerequisites: 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. Prerequisites: 80-316

80-520 Seminar on Philosophy Science

Fall: 9 units

Philosophy of Science: Social Epistemology Description: Traditional discussions of epistemology and scientific method have focused on a single inquirer interacting with the world. Both in philosophy of science and epistemology, scholars have recently become interested in the relationship between properties of social groups and successful learning in those groups. Broadly, this field has come to be known as social epistemology. This course will look at a collection of problems in this field and the various solutions to the problems. We will look both at mathematical and non-mathematical treatments of these problems. Examples of questions discussed will be: 1) Does diversity of a scientific group promote the group's ability to learn about the world? 2) Do individual psychological biases tend to promote or hamper a group's ability to learn? 3) How should communication be structured

in groups to best promote their learning? 4) How should individuals respond to disagreement with others? 5) How should groups integrate the diverse attitudes of their members?

Prerequisites: 80-413 or 80-713

80-521 Seminar on Methodology

Fall: 9 units

Ockham's razor is the vague but crucial principle of scientific method, named after the 14th century logician and theologian William of Ockham, that one should prefer simpler theories. This raises two obvious questions: what simplicity is and why one should expect the simpler theory to be true. The questions were already raised by Leibniz and Kant and have been discussed by Goodman, Quine, Lewis, Rosenkrantz, Glymour, Kitcher, Friedman and other philosophers. But the significance of the question extends far beyond philosophy, for statistics and machine learning have their own sophisticated accounts of Ockham's razor, including simplicity-biased prior probabilities, sample coverage, structural risk minimization, and Kolmogorov complexity. Each of these approaches will be examined critically and will be found either to evade or to dismiss the central question of how Ockham's razor helps one find the true theory. Then I will introduce a new foundational account of the nature and scientific role of simplicity, according to which Ockham's razor cannot point straight at the true theory but nonetheless keeps science on the uniquely straightest path thereto. The theory, which is based loosely upon H. Putnam's computational concept of "trial and error predicates" and upon the related, learning theoretic literature on "mind-changes", will be applied to causal discovery, conservation laws, curve fitting and the inference of regular sets. The course will interest anyone who cares about the foundations of scientific method and learning, including students in philosophy, psychology, statistics, machine learning, social and decision sciences, physics, biology or any area in which questions of modeling, causation, or theory choice arise. Students should have some comfort level with basic mathematical logic, probability theory, computability theory, and analysis, all of which are crucial to the topic.

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 Savages 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

Intermittent

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 exemplary 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

Department of Modern Languages

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 or placement exam.

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 also 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. 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 log-in 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 log-in 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

Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. From time to time, the Department may offer a two-semester self-instructional sequence of study in one of the so-called less commonly taught languages (e.g., Indonesian, Polish, Swahili). The course will provide individualized language instruction for students working at their own pace in consultation with a tutor using materials identified by the National Association of Self Instructional Language Programs. Courses 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 tutor. 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.

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.byuhtsc.org/?acct=cmu〈=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 82-123

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 (1) 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 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 on 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 or approved equivalent.

Prerequisites: 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.

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, or 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 determined 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 through 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.

Prerequisites: 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 European 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 discussions 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, seminar discussions and papers 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 Aeschylus' *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.
Prerequisites: 82-191

82-198 Research Training: Modern Language
Fall and Spring

This one-semester research internship is open to second semester freshmen and sophomores with a 3.0 QPA or by petition. The intention of this internship is to involve students in a faculty research project in its early stages. The Undergraduate Coordinator maintains a listing of participating faculty and the current projects on which they are willing to supervise student interns. The general interests of Modern Languages faculty include three broad categories: second language acquisition, cultural studies, and the development of innovative multi-media applications to language teaching. It is intended that students carry out a piece of individual research which will require about ten hours per week. They will be expected to produce a final report. Weekly meetings with the supervising faculty member will be arranged. Students may take this seminar only once. 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/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 elements of French grammar. Intensive practice 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. Texts may include: novels, short stories, newspaper articles, songs, television and film. Prerequisites or appropriate placement test score.
Prerequisites: 82-201 or 82-203

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 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. 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: 82-102, 82-104, or placement score. 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

82-204 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* \$50 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: 82-201 or 82-203

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.

Prerequisites: 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.

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.

Prerequisites: 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 continuation of Elementary Chinese II (82-132). Students will continue to learn the basic skills of listening, speaking, reading and writing for daily communication. More variety of expressions and complicated sentence structures will be taught so that students can carry on more sophisticated daily conversations on various topics related to every day life. While equal emphasis will still be given to both Pinyin and characters, students will be encouraged to use more and more Chinese characters with the help of Pinyin. Activities related to the broad spectrum of the Chinese culture will be organized to facilitate the language learning with knowledge of the cultural background of the language. Prerequisite or permission of the instructor.

Prerequisites: 82-132 or 82-134 or 82-135

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 more 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

Fall: 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 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. 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

82-244 Intermediate Spanish II Online

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. 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 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. 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.

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.
Prerequisites: 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.
Prerequisites: 82-172

82-272 Intermediate Japanese II

Spring: 12 units

This course is a sequel to Intermediate Japanese I (82-171) and 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. Prerequisite or approved equivalent.
Prerequisites: 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

82-276 Intensive 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

Intermittent: 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.
Prerequisites: 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.

82-291 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.

Prerequisites: 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.

Prerequisites: 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.

82-299 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 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/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 commonly associated with the French language is the primarily 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 continuing 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.

Prerequisites: 82-303

82-305 French in its Social Contexts

Fall: 9 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

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 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. \r\nStudents 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.

Prerequisites: 82-222

82-323 Germany, Austria and Switzerland in the 20th Century

Fall: 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.

Prerequisites: 82-222

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 of 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.

Prerequisites: 82-232 or 82-235

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 situations 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.

Prerequisites: 82-331

82-333 Introduction to Chinese Language and Culture

Fall

This course will introduce the students to the Chinese language and culture from a historical point of view. It is intended to help students develop awareness of and sensitivity to Chinese culture and society. Students will be exposed to different aspects of Chinese culture and their relationship with the language in the process of China's historical transformation. Class activities will include lectures by the instructor, discussions, movies, videos and other multimedia materials. The topics covered in this course include: 1. China - its land and people 2. Chinese history 3. Chinese language and its evolution 4. Chinese art 5. Chinese religions and philosophies — Confucianism, Buddhism, Daoism and popular religion 6. Chinese material culture 7. Chinese literature This is a course with either 9 or 12 units. It is conducted in English with no requirement of prior knowledge of Chinese language for those who take it for 9 units. Students who take this course towards Chinese Minor must register for 12 units, and extra work in Chinese needs to be completed for the extra 3 units. Prerequisite or instructor's approval for students seeking credits for Chinese Minor. No prerequisite for non-Minors.

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

This is an upper-level Chinese reading course for students who have reached intermediate level of Chinese. It aims at helping students further develop and refine their Chinese reading and writing skills. Its major goal is to train students the ability to read in Chinese with fluency and proficiency within a format of rich cultural content. Readings will include traditional fables, mini-stories and articles on the lifestyle and social changes in modern China. While class discussion will be the major form of class activities, students are also expected to enhance their vocabulary building and improve their sense of Chinese language through extensive reading and writing assignments. Prerequisite or approved equivalent.

Prerequisites: 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.

Prerequisites: 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.

Prerequisites: 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 would like 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

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 as 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.

Prerequisites: 82-242

82-342 Spain: Language and Culture

Fall and Spring: 9 units

This course is part of the post-intermediate, 300-level program that forms the introduction to the major or minor in Spanish. Students may begin with any one of the three or they may be taken concurrently. Spain focuses on the cultures of Spain, the autonomous regions and the creation of a national identity as a reaction to the multiple ethnicity's that have inhabited the peninsula since ancient times. The course advances proficiency in grammatical accuracy, the ability to communicate one's ideas in Spanish, and cultural proficiency. The focus of in-class activities is on written and non-written sources such as history, literature, film, art, and elements of popular culture; the building of reading and writing skills will be complemented by continued oral practice in the form of small and large group discussions and class presentations. Treatment of reading selections is designed to increase students general familiarity with a variety of genres, devices, and discourse types and to build a foundation for the department's more advanced courses in literature, history and culture. Writing assignments will involve reflective essays, individualized research, and the generation, expression, analysis and re-writing of ideas. Prerequisite: Completion of the intermediate level or the equivalent or permission of the instructor.

Prerequisites: 82-242 or 82-244

82-343 Latin America: Language and Culture

Fall and Spring: 9 units

This course is part of the post-intermediate, 300-level program that forms the introduction to the major or minor in Spanish. Students may begin with any one of the three or they may be taken concurrently. Latin America focuses on the cultures of Spanish-speaking countries in the Americas (excluding the United States), and the unique hybrid cultures formed from the fusion of indigenous, European and African influences. The course advances proficiency in grammatical accuracy, the ability to communicate one's ideas in Spanish, and cultural proficiency. The focus of in-class activities is

on written and non-written sources such as history, literature, film, art, and elements of popular culture; the building of reading and writing skills will be complemented by continued oral practice in the form of small and large group discussions and class presentations. Treatment of reading selections is designed to increase students general familiarity with a variety of genres, devices, and discourse types and to build a foundation for the department's more advanced courses in literature, history and culture. Writing assignments will involve reflective essays, individualized research, and the generation, expression, analysis and re-writing of ideas. Prerequisite: Completion of the intermediate level or the equivalent or 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 or equivalent or permission of the instructor.

Prerequisites: 82-242 or 82-244

82-345 Introduction to Hispanic Literary and Cultural Studies

Intermittent: 9 units

Spring 2010 "Transatlantic Reflections: Hispanic Cultural Encounters at the Borders from the Middle Ages to the 21st Century" During this course we will consider various texts that serve to develop definitions of the Spanish body and, in turn, the Spanish identity of the Twentieth century. From Velázquez and Goya to Picasso and Dalí, the Spanish body has been employed to communicate the grotesque, distorted and abnormal. These plastic images are also reflected in other texts such as the novels, poems and essays of Cervantes, Quevedo, Bécquer and Galdós. A brief historical introduction into those texts contributing to an explanation of the Spanish body will serve to set the basis for an in depth analysis of how this foundation either continues, is broken or is distorted in the Twentieth century. Through a panorama of texts, from film, essay and novel, to art, installation and architecture, this course will study the body as related to its political, social, emotional and psychological surroundings. That is, we will examine texts in order to further understand the Spanish body and by doing so further comprehend the Spanish identity. This course is taught entirely in Spanish. The course will be conducted entirely in Spanish. Prerequisite: Completion of two 300-level Hispanic Studies courses 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.

82-358 Literacies Across Language and Culture

Intermittent: 9 units

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: 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 links 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.
Prerequisites: 82-262

82-362 Italian Language and Culture

Spring: 9 units
82-362 Italian Language and Culture: 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 "cineforum", 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
Prerequisites: 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.
Prerequisites: 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.
Prerequisites: 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.

82-380 Independent Study in Second Language Acquisition

Spring: 9 units
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. 82-280 "Learning about Language Learning" is strongly recommended.
Prerequisites: 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 will explore the notion of second language (L2) fluency from various perspectives. The major objective of the course will be to help students develop an understanding of what it means to be "fluent" in a second language and to help them improve their OWN fluency. We will examine the notion of "fluency" itself and explore several of the common assumptions, definitions, contradictions and problems associated with the use of this commonly used term, in both first and second languages. Students will undertake a series of fieldwork projects in their second language. These projects will include explorations of native speaker perceptions of L2 fluency and analyses of how these subjective perceptions relate to actual features of language use. Students will analyze samples of their own L2 speech to see how their second language use coincides with commonly used references to fluency and ways in which they may improve their own language fluency. 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

Prerequisites: 82-292

82-392 Advanced Russian II

Intermittent: 9 units

The second part of a two-semester course sequence Prerequisite or approved equivalent.

Prerequisites: 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 and 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.

Prerequisites: 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.

Prerequisites: 82-391

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 performance, as an industry, as a means of cultural promotion, as a focus for technical innovation in instrumentation, recording, sound reinforcement, and distribution. Where appropriate we will study and listen to individual artists or groups who exemplify trends in these areas. The second half of the course will move our attention to a survey of regional development, beginning with France, then Quebec and finishing with the Cajun music of Louisiana, in what we hope is not a nod in memoriam to an important part of American culture. Prerequisite: Completion of third year courses or permission from the instructor.

Prerequisites: 82-303 and 82-304

82-404 Francophone Realities: Africa

Spring: 9 units

This course introduces students to the political and sociological histories of former French 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, Pabst, 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: 82303 or 82-304

82-415 Topics in French and Francophone Studies

Fall: 9 units

FALL 2010 This upper-level French course for the non-arts specialist will investigate the visual arts in France, from the Middle Ages to the modern era. We consider four different fields painting, architecture, photography and cinema to see how each has contributed to what the French call le patrimoine or national cultural heritage. This is a course about learning to see and learning to read a work of art, as well as learning to discuss it analytically and ask pertinent questions about it. To do this requires learning visual language: how are paintings made? how are buildings built? how is a photograph composed? In addition to learning basic technical vocabulary, students will also focus on the artwork as the product of a particular social and historical context. Student work will include analytical papers and short oral presentations on different artistic works (buildings, paintings, photographs, films), as well as a curated virtual visit to an on-line museum such as the Louvre or the Musée d'Orsay. The rise of museum culture in France and particularly Paris will also be examined. As a result of the course, students should be better equipped visually and intellectually to embrace the richness of French visual arts. A final project will require research and verbal and written presentations in a seminar format. All readings, work, and classes will be in French. Prerequisite or permission from the Instructor. Prerequisites: 82-303 or 82-304 or 82-305

82-416 Topics in French and Francophone Studies

Spring: 9 units

A series of innovative courses exploring French and Francophone literature and culture through a thematic or conceptual focus. Some courses are offered in the context of European Studies as well. Prerequisite or permission from the Instructor. 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 linguistically to contemporary readers than some other classical 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 reasons 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 fantastical 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 write 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.

Prerequisites: 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 exams 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.

Prerequisites: 82-325

82-425 Topics in German Literature and Culture

Intermittent: 9 units

FALL 2009 This course, conducted entirely in German, will explore the literature, culture, and history, of the German Democratic Republic (GDR), a state that existed from 1949 to 1990, and which is also frequently referred to in English as East Germany. Concurrent goals are to improve students' skills in reading, writing, speaking, and hearing the German language. The fall semester of 2009 marks the twentieth anniversary of the collapse of the Berlin Wall in November of 1989, and hence the course is particularly timely, marking the anniversary of an event that radically changed not only Germany but the world. The course will address not only about the German Democratic Republic but also the way that Germans today remember the GDR. The course will require extensive readings in German (about seventy pages a week), including work by Anna Seghers, Volker Braun, Ulrich Plenzdorf, and Christoph Hein; in addition students will be seeing four of the most important films made during the course of GDR history. Students will be required to complete three essays and one final project, as well as to lead a day of class discussion at the end of the semester. There will be a midterm and a final examination. Prerequisite or approved equivalent.

Prerequisites: 82-325

82-426 Topics in German Literature and Culture

Intermittent: 9 units

This class will focus on the impact globalization has had on the German people since the fall of the Berlin Wall in 1989. It is precisely due to Germany's reunification more than fifteen years ago that Germany lends itself extremely well to such an investigation: Not only did a people that had been separated and divided for forty years come together again as one nation, but specifically the downfall of socialism opened the way for the uninhibited intrusion of globalization into the East. Thus, East Germany became a microcosm of the globalizing trends found in the rest of the world, offering the rare possibility of studying the emergence of globalization from day one. We will explore the term globalization by looking at definitions of both American and German scholars and compare our findings with other terms such as 'internationalization' as well as 'Americanization.' Since globalization is usually used synonymously with the term Americanization to describe the growing colonization of the world by American consumer products, a rather hedonistic lifestyle, and fierce capitalism, we also want to examine the negative as well as positive stereotypes linked to American influences. How are American consumer products perceived among the German population? Other topics that will be explored in depth are: the globalization of the Holocaust and Germany's drive for 'normalisation;' multiculturalism in German society; the German advertising industry and their use of Americanisms; the changing face of the German literary market; globalization in recent German film; and East Germany's relationship to globalization after the fall of the Berlin Wall. 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 about Germany. 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 (or "degenerate") 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 Adon 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

Prerequisites: 82-325

82-428 History of German Film

Intermittent: 9 units

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 midterm examinations.

Prerequisites: 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.

Prerequisites: 82-324

82-432 Popular Culture in China

Intermittent: 9 units

his class is a general introduction to various aspects of popular culture in twentieth century and 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.

Prerequisites: 82-332

82-433 Topics in Contemporary Culture of China

Fall: 9 units

This fourth-year Chinese course aims at providing students with the opportunity to learn authentic Chinese used in various forms of Chinese media. Through close contact with integrated and annotated

authentic TV news broadcasts and newspaper reports, editorials and feature articles on topics related to various social issues of contemporary China, students are expected to make a breakthrough in their comprehensibility of Chinese media. Class discussion, debates and presentations on various topics will be the major forms of activities followed by essay writing to expose students to the contemporary culture of China and prepare them to function in various ways in the real situation of China in the future. Prerequisite or approved equivalent.

Prerequisites: 82-332

82-434 Studies in Chinese Traditions

Spring: 9 units

FALL 2008 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.

Prerequisites: 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

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 the course for extra language credits will 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

9 units

This course is designed to introduce students to the importance of regional and local culture in China. It will focus on Beijing which is not only the cultural and administrative center of China, but also has a rich history and local traditions of its own. Students will learn how Chinese authors reflect about local culture within the greater context of China's national culture. All readings will be selected from Chinese non-fiction prose, fiction, poetry and theater as well as film and TV drama. Class activities will include reviewing of materials, explanations on grammar, vocabulary and cultural background, discussions and oral presentations. Home assignments will include transcripts from film clips, translations, and short essays.

82-441 Studies in Peninsular Literature and Culture

Intermittent: 9 units

Fall 2010 Studies in Peninsular Literature and Culture: Panoramic Bodies: A Dissection of Twentieth Century Peninsular Texts During this course we will consider various texts that serve to develop

definitions of the Spanish body and, in turn, the Spanish identity of the Twentieth century. From Velázquez and Goya to Picasso and Dalí, the Spanish body has been employed to communicate the grotesque, distorted and abnormal. These plastic images are also reflected in other texts such as the novels, poems and essays of Cervantes, Quevedo, Bécquer and Galdós. A brief historical introduction into those texts contributing to an explanation of the Spanish body will serve to set the basis for an in depth analysis of how this foundation either continues, is broken or is distorted in the Twentieth century. Through a panorama of texts, from film, essay and novel, to art, installation and architecture, this course will study the body as related to its political, social, emotional and psychological surroundings. That is, we will examine texts in order to further understand the Spanish body and by doing so further comprehend the Spanish identity. This course is taught entirely in Spanish. Prerequisite: Completion of 82-345, equivalent, or instructor permission. Prerequisites: 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: 80-280 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

This course investigates the processes that contribute towards the unification and fragmentation of Spanish as a single language. Some of the specific topics discussed include: Spanish language history, distribution of Spanish throughout the world, processes of standardization, variation in phonology, morpho-syntax, lexis, pragmatic functions of language (e.g.: politeness, forms of address, etc.), and Spanish in contact with other languages. Students will develop their discourse analytical skills through practical language activities and field projects. They will improve their ability to express in academic Spanish through class discussions, presentations and by producing a final research paper. Prerequisite or permission of the instructor. Prerequisites: 82-342 or 82-343 or 82-344 or 82-345 or 82-346

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 problematics 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 hyphenated-Americans for overcoming, subverting or undermining this situation. Materials 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. Prerequisites: 82-345

82-446 Political Drama of Spain

Intermittent: 9 units

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 Buero 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.

82-448 TOPICS IN ARABIC LANGUAGE, LITERATURE, AND CULTURE

9 units

Under this course title, a broad range of topics relating to Arabic-speaking peoples are dealt with through multiple perspectives, for example, cross-cultural, literary, social, generational, developmental, linguistic, and historical. When offered, the course focuses on a particular topic and thus students may repeat with a different topic. Prerequisites: completion of the 300 levels or permission of the instructor

82-450 Advanced Research in Hispanic Language & Culture

Fall and Spring: 9 units

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.

82-451 Studies in Latin American Literature and Culture

Intermittent: 9 units

A sociocritical approach to the study of Latin American literature and a survey of representative authors considered in the context of the cultural heritage of Latin America. Prerequisite or permission of Instructor. Prerequisites: 82-345

82-454 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. Prerequisites: 82-345

82-455 Topics in Hispanic Studies

Fall: 9 units

FALL 2009 Radio Bemba & Beyond is a seminar/workshop in which students will familiarize themselves with the history and examples of community radio in the Hispanic world and will produce segments for the weekly Hispanic radio program broadcast on WRCT. Besides learning about the various characteristics and possibilities of this type of media, students will be able to put this knowledge into practice, while also advancing on Spanish linguistic and cultural proficiency, learning about the Hispanic community in Pittsburgh and engaging in meaningful interactions with its members, and developing research and analytic skills in the target language. Prerequisite: Completion of 82-345 or permission of Instructor. Prerequisites: 82-345

82-456 Topics in Hispanic Studies

Fall and Spring: 9 units

The origin and history of the word "monstruo" reveal its very close relationship with the word "mostrar" (to show or to demonstrate). The monster could thus be seen as a denotative sign, a dramatic signal, a mysterious call of even prophetic nature. If it is true that the Latin American monster's skin shows something and that its hyde hides something in turn, what can we learn about identity issues such as class, race, gender, and sexuality from the way of illuminating and obscuring the cultural landscape that these beings possess? How, with what purpose, and by whom are monsters created, constructed, and/or represented in Latin America? In pursuit of answers to these

questions, we will interrogate monstrous figures as they appear in written and visual texts related to Latin America, especially-but not exclusively-those produced over the second half of the 20th century. The class will be taught entirely in Spanish Prerequisite or permission of Instructor.

Prerequisites: 82-345

82-457 Contemporary Latin American Texts: Revision, Rewriting and Representation

Intermittent: 9 units

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 historicized 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.

Prerequisites: 82-342 or 82-343 or 82-344 or 82-345 or 82-346

82-473 Topics in Japanese Studies

Intermittent

Under this course title, a broad range of topics relating to Japan and the Japanese people are dealt with through multiple perspectives e.g., (cross-)cultural, social, generational, developmental, linguistic, and historical. When offered, the course focuses on a single topic and thus students may repeat with a different topic. Topics currently offered under the course title are Changing Cultural Icons Samurai, Kamikaze, and Totoro , Japanese Family through Cinema, and Youth Culture. Further topics will be added as they become available. This course is offered intermittently in fall. Prerequisite or approved equivalent.

Prerequisites: 82-372

82-474 Topics of Japanese Studies

Intermittent: 9 units

Under this course title, a broad range of topics relating to Japan and the Japanese people are dealt with through multiple perspectives e.g., (cross-)cultural, social, generational, developmental, linguistic, and historical. When offered, the course focuses on a single topic and thus students may repeat with a different topic. Topics currently offered under the course title are Changing Cultural Icons Samurai, Kamikaze, and Totoro , Japanese Family through Cinema, and Youth Culture. Further topics will be added as they become available. This course is offered intermittently in spring. Prerequisite approved equivalent.

Prerequisites: 82-372 or 82-373

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 or approved equivalent.

Prerequisites: 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.

82-481 Research Methods in Second Language Acquisition

Spring: 9 units

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.

82-483 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 instruction and learning. 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

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 ways 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 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, filmmaking, 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

Pushkin, Gogol, Lermontov, Turgenev, Dostoevsky and Tolstoy all ruminated upon their nation's historical destiny. This course aims to describe the role played by imagination in these authors' efforts to wreak from Russia's past a vision of her future. Emphasis is placed upon the figurative operations of language that allow narrative to function as a guidepost to a collective mission and a map of the individual's location within the projected historical scheme. Lecture and discussion formats are combined at each class meeting. Written papers, oral presentations, and participation in discussions are required. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

Prerequisites: 82-292

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 in the metaphysical poetry of England's Renaissance and Modern ages. To read 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 means 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 format. Reading 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 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.

82-501 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 reflexive 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

82-532 Special Topics Chinese

82-541 Special Topics: Hispanic Studies

Fall

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.

82-542 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

This course aims to enhance students' awareness of pragmatic implications in their every day communication, as well as issues that L2 learners face when learning the implications in their course of L2 development. The goal of this course is twofold. First, this course will help students to develop techniques to analyze the linguistic means that people use to achieve pragmatic functions in real life communication. The techniques will be drawn from frameworks within traditional pragmatic theories and approaches (e.g., Speech Act Theory, Relevance Theory, Grice's maxims). Students will apply these techniques to analyze communicative practices in authentic spoken and written materials (in their L1 or L2). The second goal is to have students to critically examine applications of pragmatic theories to L2 research in three broad areas: L2 use, development, and pedagogy, which encompass four major strands in the existing literature: - Application to interlanguage analysis - Application to the models of L2 competence and proficiency - Application to the analysis of L2 development - Application to L2 instruction Through critical examinations of the literature in the four strands, students will develop understanding of the role of pragmatics in L2 research and teaching.

82-591 Modern Languages Honors Thesis

Fall: 9 units

Modern Language majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of an individual faculty member. Students and faculty select the research topics. Prerequisites: Senior standing; a 3.5 QPA in one's language major; a 3.25 QPA overall; permission of the Department Head and approved entry into the College's Honors Program.

82-592 Modern Languages Honors Thesis

Spring: 9 units

Modern Language majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of an individual faculty member. Students and faculty select the research topics. Prerequisites: Senior standing; a 3.5 QPA in one's language major; a 3.25 QPA overall; permission of the Department Head and approved entry into the College's Honors Program.

82-599 Russian Studies Thesis

Intermittent

This course consists of researching and writing the thesis that is required of Russian Studies majors. It is generally completed during the senior year. See Russian Studies Major description. Work is done individually, under the guidance of a Russian Studies advisor. Prerequisite: Permission of the Instructor.

Department of Psychology

85-100 Introduction to Intelligence in Humans, Animals and Machines

Intermittent: 9 units

A practical as well as theoretical introductory course aimed at increasing the students learning, problem solving, decision making and critical thinking skills. The course will begin by contrasting between intelligent and instinctive behaviors. It will then examine the roles that perception, learning, curiosity, problem solving, decision making, and language play in enabling humans and other animals to behave intelligently. Special attention will be paid to language in animals and to the nature of creativity. Finally, the course will examine the similarities in and differences between animals (including humans) and machine intelligence.

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. Prerequisites: 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 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: 85-261

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.
Prerequisites: 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 criticize 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.

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.
Prerequisites: 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, neurophysiology, 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. But 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. Prerequisites: 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 Cross Cultural Psychology

Intermittent: 9 units

Human beings share a common genetic inheritance, but our cultural institutions differ in a bewildering variety of ways. This course explores the many different cultural expressions of basic human cognitive and social abilities and needs. We will look at cultural variations in child rearing, mother-child attachment, language socialization, categorization, reasoning, problem-solving, architecture, music, politics, warfare, food-gathering, sex roles, mental disorders, and altered states of consciousness, all with the goal of understanding how the shape of social systems and symbolic expression reflects the economic and adaptive needs of the culture and its people. Among the approaches to these phenomena we will consider are symbolic interaction, cognitive anthropology, dialectic materialism, and modern ethnology.

Prerequisites: 85-100 or 85-102 or 85-198 or 85-211 or 85-219 or 85-221 or 85-241 or 85-251 or 85-261

85-377 Attitudes and Persuasion

Intermittent: 9 units

This advanced undergraduate course will focus on the topic of attitude change and how various persuasive techniques are used to shape human response. 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.

Prerequisites: 85-241

85-380 In Search of Mind: The History of Psychology

Intermittent: 9 units

This course will focus on three aspects of the origin and growth of experimental psychology. The first is the prehistory of psychology, where the connection of the discipline to the development of modern science, and in particular, its origins in philosophy and physiology, is examined. The second focus of the course is on the different approaches and attempts to define the field that have contested for dominance during much of the life of the discipline. The final major focus of the course is on the modern period (roughly the last forty years) where the influences that brought about the modern counter-revolution in psychology will be examined, and where some conjecture about likely future directions will occur. Two prior courses in psychology.

85-382 Consciousness and Cognition

Intermittent: 9 units

This course will examine the relationship between cognition and consciousness. One particular focus will be on the issue of how complex the 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 briefly 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 monitoring, 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 employ 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 ergonomics. 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. 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.

Prerequisites: 85-102 or 85-211 or 85-213 or 85-370

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, perception, 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 enter 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: 15-211

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 their implications for these 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 parses 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.

Prerequisites: 85-221

85-423 Cognitive Development

Spring: 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 children's information processing capacity and the effect that differences in capacities have upon the child's ability to interact with the environment in problem solving and learning situations.

Prerequisites: 85-221

85-426 Learning in Humans and Machines

Spring: 9 units

This course provides an introduction to probabilistic models of cognition. The focus is on principles that can help to explain human learning and to develop intelligent machines. Topics discussed will include categorization, causal learning, language acquisition, and inductive reasoning.

Prerequisites: 15-121

85-429 Cognitive Brain Imaging

Intermittent: 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

Internship in Clinical Psychology introduces students to clinical psychology and related fields through course-work and practicum experiences. Students have the opportunity to work in applied research and/or clinical settings, in conjunction with learning about clinical psychology practice. Examples of available internship placements are: Western Psychiatric Institute and Clinic, Contact Pittsburgh, The Parental Stress Center, and The Children's Institute. 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 Kurtz 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 storytime. 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 a 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. Prerequisites: 85-221

85-501 Stress, Coping and Well-Being

Intermittent: 9 units

This course will examine the relationship of stress and coping to psychological and physical well-being. Discussions will be centered on readings from current theoretical and empirical articles. Anticipated discussions include the definitions of stress and coping from multiple theoretical perspectives, issues relevant to the measurement of stress and coping, the psychological and physical consequences of stress, the time course of assessing well-being, and "adaptive" vs. "maladaptive" coping responses. This class is a small, upper level seminar that will consist of minimal lecture and a majority of class discussion. Active class participation is required.

Prerequisites: (85-241 and 85-340) or (85-251 and 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 QPA 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 (66-501,602) in that it does not require Honors standing in HSS (i.e., there are no QPA 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.

Department of Social and Decision Sciences

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

Intermittent: 9 units

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 the 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 typist/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 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 with 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. In particular, we will focus on how cognition and emotion shape judgment and choice. Class meetings will include a mixture of lecture and discussion. We will address such questions as: In what ways do specific emotions influence judgments and choices? What are some common mistakes in judgment and decision making? How do attitudes form and change? 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 of 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, 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 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 QPA 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.

88-202 History of Public Policy in the United States

Fall: 9 units

This course will describe and analyze 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, competition policy, the New Deal, civil rights, and drug policy.

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 emphasizing 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 in 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: 73-250 or 73-251 or 88-220

88-222 Policy Analysis III

Fall and 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.

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

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 on 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?

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 illnesses. It also investigates decisions surrounding the treatment of mental illness, such as the efficacy of existing 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-interactive 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 attitudes, 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.

88-329 American Foreign Policy: 1945-Present

Fall and Spring: 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," "détente," 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.

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

Incandescent and fluorescent electric lights; nylon and Kevlar®; the atomic bomb; the transistor and integrated circuits; Post-it®; notes; Teflon®; Silly Putty®; GameBoys®; and biopharmaceuticals (from Viagra®; and Levitra®; to Paxil®; and Enbrel®;), among a panoply of other consumer and industrial goods, are all products that emerged from organized industrial research and development (R&D) programs. The beginnings of this new institution in the late 19th century, its rapid rise in the first third of the 20th century, its flourishing in the middle third of the 20th century, and its decline and reorganization in the last decades of the 20th century and first decade of the 21st century are the principal focus of this advanced reading seminar. What factors led to the establishment of modern R&D? Why did industrial R&D laboratories appear in the US and other industrialized nations? How did their creation change the character of science, technology, and business? How did the institutionalization of R&D affect the work of individual inventors, engineers, and scientists? Does big business now dominate R&D in the United States, or does the little guy (including university-based start ups) still play an important role in technological innovation? What about the interaction of universities and industrial R&D programs? How has industrial R&D been managed? How has federal science and technology policy affected industrial R&D? With the globalization of business, is industrial R&D also becoming global, and if so, how does industrial R&D work on a global scale? Why did the last decade of the 20th century see the decline or disappearance of numerous prestigious industrial research organizations? What is the future of industrial R&D in the 21st century? These are some of the questions explored in this course, which is open to serious students from all colleges.

88-346 Environmental History and Politics Since Silent Spring

Spring: 9 units

This course explores the development of the modern environmental movement and its impact on American politics since the publication of Rachel Carson's landmark study, *Silent Spring*, in 1962. It also examines the role of the state in creating and enforcing meaningful environmental regulations at a time when people were transitioning from a conservation approach to natural resources to a health or environment-based approach. Topics that will receive particular attention include toxic waste cleanup, river and drinking water regulations, water conservation in the west, agriculture, and the distinct interrelationships between urban and rural environments and their constituencies.

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.

88-357 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.

88-358 Policy Making Institutions

Fall: 9 units

Institutions are the "rules of the game" that provide the incentives and constraints for individuals and group behavior. In the U.S., policy institutions range from Constitutional provisions (e.g., separation of powers, federalism) to specific legislation and regulations to informal norms and customs of political parties and interest groups. In this course, rational choice theory and simple spatial modeling are used to explore how preferences and institutions shape policy outcomes, along with the factors that lead to institutional changes. Topics include the role of supermajoritarian institutions and legislative "gridlock," the privatization of government services, and the causes and consequences of electing versus appointing judges.

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 economic 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.

88-364 Psychobiology and Decision Making

All Semesters: 9 units

This course provides an introductory survey of the methods and findings in "neuroeconomics" and the psychobiology of decision making. Half the course is lecture style and covers the basics of neuroanatomy, neurochemistry, and neuroendocrine systems, highlighting the neuroscience methods (neuroimaging, neuropsychological, psychophysiological, transcranial magnetic stimulation, etc.) and some main findings related to decision making. The other half of the course is more like a seminar, where each week we will discuss a couple seminal empirical papers from the scientific literature.

Prerequisites: 85-102 or 85-211

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.

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: 73-251 or 79-202 or 88-202 or 88-220

88-372 Social and Emotional Brain

Intermittent: 9 units

This course provides an introductory survey of the methods and findings in social and affective neuroscience. Half the course is lecture style and covers the basics of neuroanatomy, neurochemistry, and neuroendocrine systems, as well as a survey of relevant neuroscience methods (neuroimaging, neuropsychological, psychophysiological, transcranial magnetic stimulation, etc.). The other half of the course is more like a seminar, where each week we will discuss a couple seminal empirical papers from the scientific literature. Topics include interpersonal relationships, prosocial behavior, aggression, prejudice, emotion regulation, stress, etc. (As a pre-requisite, students must have taken 85-102, 85-241, or 88-120. Students who took 88-364A last year may take this course, but they will be expected to complete an additional assignment.

Prerequisites: (80-371 or 80-372) and (76-270 or 76-271 or 76-322 or 76-372 or 76-375 or 76-391 or 76-395 or 76-396 or 76-472 or 76-478 or 76-491 or 76-492) and (15-120)

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 response. 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.

Prerequisites: 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.

88-384 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 non-state 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 Algiers 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 - and 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.

Prerequisites: 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.

88-391 Technology and Economic Growth

Fall: 9 units

The importance of economic growth is difficult to overstate. The more than tenfold increase in income 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 research or other independent academic study 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 topic. Prerequisite: Permission of a faculty sponsor.

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.

88-410 The Global Economy: A User's Guide

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, and 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—and 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 sewn together by lectures, films, and various unorthodox pedagogical methods.

88-415 Global Competitiveness: Firms Nations, and Technological Change

9 units

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 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 a wide variety of context: public policy negotiations, business negotiations, and inter-personal 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.

88-423 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.

88-444 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.

88-501 SDS Senior Honors Thesis I

Fall: 9 units

Majors in the Social and Decision Sciences Department 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 faculty. Prerequisites: Senior standing; a 3.5 QPA in one of the Departments majors; a 3.25 QPA overall; permission of the Departments faculty; and approved entry into the Colleges Honors Program.

88-502 SDS Senior Honors Thesis II

Spring: 9 units

Majors in the Social and Decision Sciences Department with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Prerequisites: 88-501

88-505 Undergraduate Internship

All Semesters

An internship is an approved and monitored work experience than 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 in the department.

Carnegie Mellon University-Wide Studies

99-101 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).

99-102 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).

99-103 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 have been responsible for the infrastructural developments that have cradled old societies. 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 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 ancient and Renaissance astronomy as well as classical physics. 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 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 future indifference, and the question of what purpose 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 warning marker 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 plays. 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/acadev/studentjobs/peertutor.html>) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications.

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/acadev/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/acadev/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

This course supports the development and improvement of the dozens of educational outreach endeavors implemented by university academic departments, student organizations and others. It is noted that the Regional Impact Pillar of Carnegie Mellon's strategic plan, which specifically states, We will continue to support improvements in K-12 education in the region, through both research and community service. It is important that we continually review, evaluate and improve the educational outreach offerings of the university to ensure that accurate information is being disseminated to the appropriate audience in a way that does improve some aspect of life in the community. Students must prepare a final work product such as a report that demonstrates independent learning was achieved. For example, if the work is to determine the effectiveness of a university educational outreach program on the targeted population, the report should include information about the program, a review of literature related to the program goals, methods used to determine effectiveness (including any IRB approvals that are necessary), a summary of results, and recommendation of program improvement. Other projects may be designing and implementing a new outreach offering, creating a more effective method for university students to learn about and participate in educational outreach programs, or in-depth research about a topic related to education of children, such as the funding system for public schools or a review of the preparation of teachers for classroom experiences across several countries. Note that these are not the only type of projects that are acceptable, and when registering for the independent study, students must submit a proposal for the work to the instructor.

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.

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